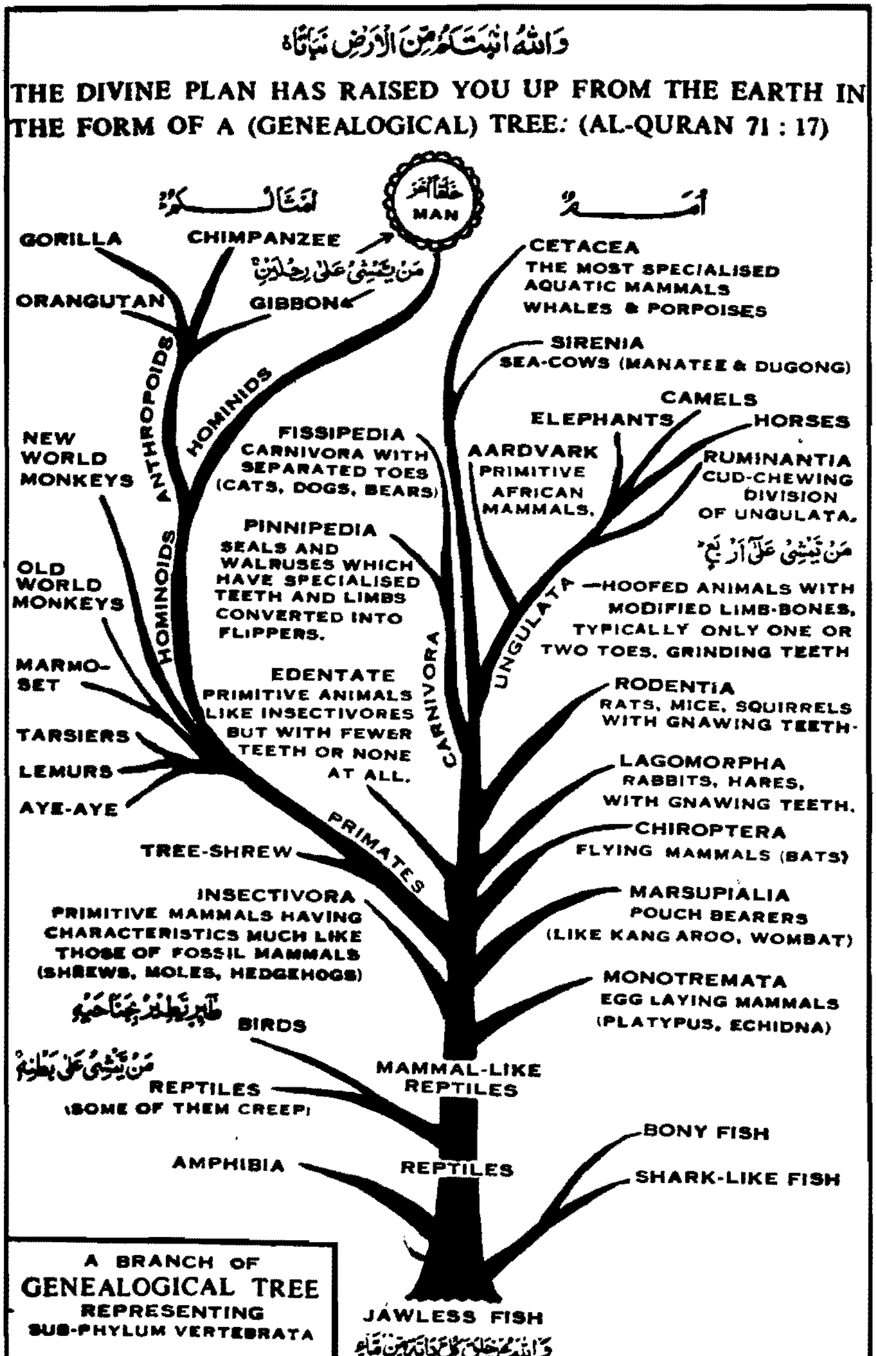
بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ ۝

سَنُرِيْهِمْ اٰيٰتِنَا فِى الْاٰفَاقِ وَفِىْٓ
اَنْفُسِهِمْ حَتّٰى يَتَبَيَّنَ لَهُمْ اَنَّهُ الْحَقُّ ط

"We will show them Our Signs in the universe and within themselves, until it becomes manifest unto them that this (The Quran) is the truth.

(Al-Quran, 41 : 53)



Tree-like pattern of evolution

Frontispiece

PHENOMENA OF NATURE AND THE QURAN

BY

SAYED ABDUL WADUD
M.C., M.B.B.S.

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To

My talented teacher

Allama Ghulam Ahmad Parwez

whose brilliant and fascinating exposition

of the Holy Quran inspired me to earnestly explore

the Divine Message.

THE AUTHOR

Preface -- to the First Edition

This book does not pretend to be more than what its title implies. It is not a textbook of science but an explanation of certain Quranic verses, on the basis of science. It could be produced in two different forms. Firstly by taking the verses related to the phenomena of nature as they occur successively in the Quranic text and by explaining each of them in the light of modern scientific knowledge; secondly by taking up separate chapters on the various branches of science, describing the scientific basis first and then stating what the Quran has said about it. I have adopted the latter course, so that the non-scientist readers may be able to follow it with ease. The main object, however, in writing this book is to present the Holy Quran to the world scientists.

As far as the scientific data is concerned, I have not added anything to it. It is the outcome of the research and observations by the eminent scientists in different ages. However, I have projected the Quranic verses in order to bring into light the harmony between the Quran and the scientific studies and to show that an intelligent approach to the study of the Holy Book demands knowledge of the modern sciences.

I have not given a literal translation of the Quranic verses, since in the words of Gibb, "the Quran is essentially untranslatable"*; but interpretations thereof are based on reason or a deeper broad-based study of the general teachings of the Book, which might differ in some places from their orthodox meanings. I have however the authority of the most reliable Arabic lexicons for what I have said.

I am indebted to Allama Ghulam Ahmad Parwez whose explanatory lectures on the Holy Quran, spread over years together, provided an intiative for this venture, and whose vast and valuable literature on the Holy Quran, advice and moral support maintained the impetus behind my humble efforts : to late Professor S.S. Ahmad, ex-head of the Biology Department, Government College, Lahore, for his affectionate guidance in completing the figure work and for taking pains in spite of his poor health : to late Professor Hamid Askari for hints on certain physical aspects of natural phenomena : to Dr. Badrud-Din, Director, Institute of Chemistery, Punjab University, for checking up the chapter on Chemical Evolution : to Mr. Jafar Ali Qureshi for checking up the typed matter : to Hafiz Mohammad Yousaf and Munshi Saeed Ahmad for calligraphy of certain Quranic verses : to the Ripon Printing Press Ltd. for their devoted care and cooperation : to my wife for her solicitude that eased the strain of what was added to my professional work : to my deceased parents who kindled in me the flame of love for the Holy Quran and the last word on the subject is -- Absolute praise is for Allah, the Nourisher of all domains of existence. This cry comes spontaneously from the believers who ponder over phenomena of nature.

... وآخر دعواهم أن الحمد لله رب العالمين۔ (10:10)

Lahore, 1971

ABDUL WADUD

---

*H.R. Gibb, *Modern Trends in Islam*, University of Chicago Press, 1945, page 4.

Preface -- to the Second Edition

In addition to the minor changes, certain detailed discussions have been added to the second edition of the book.

A narration in chapter-II related to "The end of the Universe", has been omitted. This is present in more details in my book titled "The Heavens, the Earth and the Quran". Chapter-III has been revised, under the new heading, "The Well-Gaurded Roof."

In chapter-V "Chemical Evolution", the pre-biological phase of chemical evolution has been revised. In chapter-IX "Enviornments and Nutrition" the verse (25:53) of the holy Quran has been explained in further details, by quoting a particular event that occured in the year 1915 A.D., on the sea of Marmara.

In chapter-XI pattern of "Reproduction", after the heading "Significance of Sex" an explanation of the word مودّت as it occurs in the Quran (مودّت 30:31, اَلْودُود 85:14) has been added.

In chapter-XII "Reproduction of Multicellular animals" the viable age of fetus has been discussed with reference to the Quranic verses 2:233, 46:15, and 31:14, and also with reference to Ahadith literature.

I am indebted to my friend Mr. Mohammad Omar Darz the Chief Executive of Annoor Printing Press, for taking special pain in the re-arrangement of the text of the work, and for the setting and re-setting of the figure work.

Lahore, 1992 — **ABDUL WADUD**

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Introduction

The contents of the Holy Quran comprise injunctions, laws and permanent values which form the fundamentals of Quranic teachings and which are intended to guide the destiny of man kind. The Quran also relates historical facts as well as the phenomena of nature, in support of the truth of the above said fundamentals. Some of these descriptions are allegorical and these are related to different aspects of human life.

Though there are some excellent works on the interpretation of the tenets of the Holy Quran, a scope is always there for a scientific consideration of those verses which point towards the phenomena of nature. Unfortunately the study of science and that of the Holy Quran have been segregated and encompassed into two water-tight compartments; firstly by our religious leaders who rejected science and secondly by the scientists who never had a chance to explore the depths of the relevant verses of this final, complete and the only revealed book now present, on the face of the earth, in its original and unadulterated form.

The above remarks are, however, with apology to the Muslim scholars of the early Islamic era, who made valuable contributions to the science of Chemistry, Astronomy, Mathematics, Biology, Medicine, Optics and Archaeology etc. At the end of this book I have given brief description of the works of some of the Muslim scientists of middle ages, along with the list of others whose works influenced the scientific thought in Europe till the 17th century A.D.

Stagnation in scientific research started only when the dynamic teachings of the Quran were no more allowed to operate upon the day to day life of the Muslims and the Quranic social order got out of sight.

Object. The object of this dissertation is to show that the Quran is the book revealed by Allah and is not the outcome of human imagination. This can be proved in so many different ways but I shall deal with certain verses of the Quran pertaining to the creation of man and that of the universe. These verses were revealed fourteen hundred years ago to a person who was addressed by Allah as follows:

وَمَا كُنْتَ تَتْلُوْا مِنْ قَبْلِهِ مِنْ كِتٰبٍ وَّلَا تَخُطُّهُ بِيَمِيْنِكَ اِذًا لَّارْتَابَ الْمُبْطِلُوْنَ۔ (29:48)

"And you were not able to recite a book, before this (revelation), nor were you able to transcribe one with your right hand; in that case indeed would those who reject truth, have doubted".

The Quran has argued that Muhammad, the last messenger of Allah (PBUH), was not able to read and write. If he had the faculty of reading and writing, there would have been some plausibility in the charge of vainglorious opponents that he spoke not from inspiration but on the basis of his knowledge from other sources, through reading and writing; and that he composed the verses of the Quran himself. On the other had, what I want to impress upon my readers is that even if the "Rasul"* was a literate person, it would have been impossible fourteen hundred years ago by any human being to affirm from his personal knowledge or from the knowledge gained from worldly resources what the Quran affirmed at that time. The level of human knowledge in general, and so far as the scientific discoveries were

*"Rasul" means a person who delivers to mankind the Divine Message revealed to him by God. He is a "Nabi" as well as a "Rasul" i.e., the recipient of Divine Guidance as well as its deliverer: 'Risalat' and 'Nubuwwat' being thus the two facets of the same coin. The Holy Quran has described the characteristics of "Rasul" in various contests in the following terms:-

(1) He was one amongst the human beings. (18: 110)

(2) He spoke nothing but the truth.

(3) He himself was the first to obey and act upon the message he carried. (6:164)

(4) He not only carried the message but introduced it as a social order amongst his people. (40: 66)

(5) He never sought for becoming a "Nabi" and a "Rasul", but he was chosen for it, as he was considered capable of discharging the huge responsibility entrusted to him (42:52)

(6) He never knew beforehand that he was going to receive the Divine revelation, until it actually came to him (28:86)

(7) He was sent to the people, to be obeyed only in accordance with the Divine Guidance. He never made people slaves to his own whims and wishes. (3:78-79 and 4:64)

(8) He was neither superhuman, nor possessed any supernatural powers; like other human beings he was also subjected to the laws of nature and responsible for his mistakes, if any. (34:50)

(9) He asked no reward for what he did for mankind. (10:72)

(10) The last "Rasul", Muhammad (PBUH), was given the final and complete code of life, to serve as a guidance for all the future generations of mankind; and was entrusted with the function of establishment of a social order according to that code (the Quran). 'Nubuwwat' therefore came to an end with him and the responsibility for the establishment of the social order referred to above devolved, thereafter, upon those who believe in the Quran.

The writers in English language use the word "holy Prophet" for Muhammad (PBUH). It s a misnomer and too small a word to be used for a person holding such an exalted position. The word 'prophet" means one who foretells events and originally it was put into use by the Jews who had such foretellers in their ranks, inside their temples. The word has no relevance to the high position of one who is not only the recipient of Divine Guidance but is also entrusted with the responsibility of putting it into practice.

The word "Nabi" actually means, "one standing on a very high place", and the Quran has used the word in this sense, meaning thereby, the recipient of Divine Message. There is no word in English equivalent to the word "Nabi"

We shall therefore avoid the word "prophet" in this book and use the word "Rasul" or "Nabi" instead.

concerned in particular, that existed at that stage, was extremely low. The Quran had pointed towards so many phenomena which modern science has discovered during the last three or four centuries, or even during the last few decades; and many others which science has not been able to discover so far. In fact the more the human knowledge advances, the more it becomes manifest that all that is presented in the Quran is well founded on veritable truth. The circumstances under which the Quran appeared on the earth bear testimony to the fact that it is beyond doubt a unique book revealed by Allah to His last messenger,

Significance of natural Phenomena as described in the Quran. It may be pointed out here that the Quran is not a book of Geology, Astronomy, Anatomy or Embryology; though it describes in so many different ways the moral and material aspects of human life blended together, and these descriptions lie scattered all over its pages.

It is an extraordinary feature of the Quran that although it stands on the platform of religion, it presents the organisation of the material world as an evidence to prove the truths presented by itself. The basic concept of the Quran is the RULE OF LAW. Although its ultimate object is the sovereignty of the divine laws in the human world, but the rule of law can be easily realised in a palpable form in the organisation of the material world. That is why the Quran presents the world of matter, as an evidence in support of its truths.

According to the Quran you come to know Allah through His creation.

(6:1) اَلْحَمْدُ لِلّٰهِ الَّذِىْ خَلَقَ السَّمٰوٰتِ وَالْاَرْضَ وَجَعَلَ الظُّلُمٰتِ وَالنُّوْرَ ؕ

"Praise be to Allah Who created the heavens and the earth and made the darkness and the light"

Thus when we come across a beautiful and attractive object, we see it with our eyes, our mind appreciates it and our tongue expresses the words of praise. When we say 'Alhamd-o-lillah', we express our appreciation of Allah. But it is essential that we see an object with our own eyes before we express our feelings of appreciation. On the other hand, we are not able to see Allah. The Holy Quran says:

(6:103) لَا تُدْرِكُهُ الْاَبْصَارُ ز

"No vision can grasp Him"

An infinite object cannot be grasped by finite one. The question arises as to how can we appreciate an object which is not detectable with our senses. In fact when we praise the art of an artist, the praise of the artist himself is automatically included in it. The objects of Allah's creation are lying scattered in every nook and corner of the universe. Some of them are present before us in a manifest form but innumerable ones lie hidden from us. With a determined effort and application of mind we can explore and dig out these hidden treasures. As soon as we glance at their beauty and architectural skill, we at once proclaim the words of praise 'Alhamd-o-lillah'.

The Holy Quran repeatedly impresses upon our mind to go deep into the knowledge of Allah's creation and makes it obligatory for the believers to explore nature:

وَفِي الْأَرْضِ آيَاتٌ لِلْمُوقِنِينَ ۝ وَفِي أَنْفُسِكُمْ ۚ أَفَلَا تُبْصِرُونَ

(51:20-21)

> "In the earth are clear signs for those who get convinced(after thorough investigation and research); and also within yourself. Then, will you not exercise your vision?"

The Holy Quran uses the word علماء (learned men) for scientists (35:28). Thus to know the creation of Allah is to know Allah. The more we explore nature, the more we get firm in our belief in the Creator.

The rays of light make it possible for us to distinguish the features and the exact location of the objects around us. That is why the Holy Quran itself is called Light:

... قَدْ جَاءَكُمْ مِنَ اللَّهِ نُورٌ وَكِتَابٌ مُبِينٌ

(5:15)

> "Surely the light has come to you from Allah in the form of a perspicuous book."

After we explore and dig out the obscure objects and phenomena of nature, it is the Holy Quran which tells us how to utilise the fruits of our efforts. Thus the exploration of nature and the light of revelation are the two wheels on which the cart of life moves forwards. You miss any one of them, the progress of human life stops. Nations with advanced scientific knowledge and without the light of revelation are still groping in the dark. They are like a caravan with valuable treasures in their packs but being unable to find landmarks, are wandering aimlessly on the highway of life. On the other hand, the bearers of Quran, without scientific knowledge, are like a blind man carrying a searchlight in his hand.

The valuable resources gained by the scientific research, utilised in the light of the Permanent Values provided by the Holy Quran, make life on the earth worth living. Moreover, the revelation unveils the ultimate human destination, as well as the road to destination with its sign-posts which become clearly visible.

CHAPTER I

The Quran on Creation of the Universe

اَلْحَمْدُ لِلّٰهِ الَّذِیْ خَلَقَ السَّمٰوٰتِ وَ الْاَرْضَ وَجَعَلَ الظُّلُمٰتِ وَالنُّوْرَ (6:1)

The entire creation of the universe and the various aspects of life on the earth are so attractive and captivating, for one who uses his intellect and vision, that he spontaneously expresses his feelings of praise for the One Who created the heavens and the earth, and made the darkness and the light (of revelation).

The Holy Quran describes Allah as فَاطِرِ السَّمٰوٰتِ وَالْاَرْضِ (6:14), which means that Allah is one who created the heavens and the earth for the first time when there was nothing in the universe. At another place the Holy Quran says:

بَدِیْعُ السَّمٰوٰتِ وَالْاَرْضِ وَ اِذَا قَضٰۤی اَمْرًا فَاِنَّمَا یَقُوْلُ لَهٗ كُنْ فَیَكُوْنُ - (2:117)

> "He is the Originator of the heavens and the earth. When He decrees a plan, He says to it BE and it is".

Again it is said:

اِنَّمَاۤ اَمْرُهٗۤ اِذَاۤ اَرَادَ شَیْـًٔا اَنْ یَّقُوْلَ لَهٗ كُنْ فَیَكُوْنُ - (36:82)

> "His law of creation is such that when He intends a thing, His decree is BE and it is".

The underlying idea in the above verses is that Divine intentions and decisions are in fact an integral part of Allah's process of creation. The Holy Quran has used two different words for creation. They rather indicate the two different stages of creation. One is *Amr* (امر), the other is *Khalq* (خلق). *Khalq* means to create a new object from the existing constituents. This is where an object appears in its manifest form. But prior to this is a stage where an object is still in the process of 'becoming'. This planning stage is described by the Holy Quran as *Alam-e-Amr* (عالمِ امر). What is the nature of this planning and how it is carried out is beyond human imagination.

This is also described by the Holy Quran as *Mashiyyat* of Allah which nobody can question.

(14:27) يَفْعَلُ اللّٰهُ مَا يَشَآءُ -

"Allah acts according to His will".

Here 'will' does not mean whims and wishes. It means a set of laws.

(21:23) لَا يُسْـَٔلُ عَمَّا يَفْعَلُ -

"He cannot be questioned for His acts".

For example, fire burns. Why fire is given the burning property, nobody can question. Why water flows downwards and not upwards? Why an apple detached from a tree, falls downwards and not otherwise? Why the inner 'shell' of an atom has got two electrons and not more than two, nobody can question.

The word *Amr*, as it occurs in various other contexts in the Holy Quran, requires further elucidation. It means a guidance, or guidance by command. There are two other aspects of this guidance. Firstly, the laws governing the phenomena of nature. These are also called *Amr*. For example the Holy Quran says:

(7:54) وَ الشَّمْسَ وَالْقَمَرَ وَالنُّجُوْمَ مُسَخَّرٰتٍۢ بِاَمْرِهٖ ؕ

"The sun, the moon and the stars are subservient to His (command) law"

Let us take another beautiful example where the Holy Quran uses the word *Amr* for the laws governing the floating of ships on the sea. We find in the world of Science that a body wholly or partially immersed in a fluid, suffers loss of weight, equal to the weight of the fluid displaced (Archimede's principle). If the weight of the body is greater than the weight of the fluid displaced, it sinks. If the weight of the body is less than the fluid displaced, it floats. When a body is floating on the surface of a fluid, a portion of the body is immersed in the fluid, so that the weight of the fluid displaced by the immersed portion is equal to the weight of the entire floating body. This is the law according to which the ship floats on the water. The Holy Quran says:

اَلَمْ تَرَ اَنَّ اللّٰهَ سَخَّرَ لَكُمْ مَّا فِى الْاَرْضِ وَالْفُلْكَ تَجْرِىْ فِى الْبَحْرِ
(22:65) بِاَمْرِهٖ ؕ وَ يُمْسِكُ السَّمَآءَ اَنْ تَقَعَ عَلَى الْاَرْضِ اِلَّا بِاِذْنِهٖ ؕ...

"Do you not see that the law of Allah has made subject to you all that is on the earth; and the ships that sail through the sea by His (*Amr*) law. He withholds the heavenly bodies from falling on the earth, except according to His law".

Another phenomenon of nature described in the above verse, is that the celestial bodies do not fall on the earth. And in case they do fall, that also is according to law. We shall discuss this phenomenon in the description of meteors and meteorites..

EXECUTION OF LAWS-

Thus, as stated above, the initiative of Divine laws was absolute and unquestionable. Now, the execution of these laws is carried out within specified patterns. This is known as *Taqdir* (تقدیر).

(33:38) وَكَانَ اَمْرُ اللّٰهِ قَدَرًا مَّقْدُوْرًا

"The Divine laws are bound by certain measures".

(65:3) قَدْ جَعَلَ اللّٰهُ لِكُلِّ شَيْءٍ قَدْرًا ۔

"Allah has made a specific pattern for everything that exists".

(25:2) ... وَخَلَقَ كُلَّ شَيْءٍ فَقَدَّرَهٗ تَقْدِيْرًا ۔

"It is He Who created, all things and bounded them by measures".

A mango seed shall always grow into a mango tree: A human embryo shall always grow into a human being. This is its *Taqdir*. Thus, after the initial planning, the execution of these laws has been channelised. The more we explore nature, the more we gain knowledge of these laws. But our knowledge is confined only to the extent of finding out how these laws work. Why do they work as such, we do not know.

Secondly, the laws that govern human affairs and were given to mankind through Allah's messengers are also called *Amr*. These laws are today lying in safe custody inside the Holy Quran only. They govern the rise and fall of nations and also the development of the personality of an individual human being, and are known as قانون مکافات عمل : The Holy Quran says:

... وَلٰكِنْ لِّيَقْضِيَ اللّٰهُ اَمْرًا كَانَ مَفْعُوْلًا ۙ لِّيَهْلِكَ مَنْ هَلَكَ عَنْۢ
(8:42) بَيِّنَةٍ وَّ يَحْيٰى مَنْ حَيَّ عَنْۢ بَيِّنَةٍ ۭ وَاِنَّ اللّٰهَ لَسَمِيْعٌ عَلِيْمٌ

"But Allah had decided to execute a plan that had to be carried out, so that he who perishes must have an obvious cause of his death and he who survives must have an obvious cause of his survival. And verily Allah is one Who is All-hearing and All-knowing".

We may summaries that the guidance or guidance by command of Allah works in three different ways: (1) The first being the planning of certain schemes and the initiation of laws that govern the execution of these schemes. (2) The second being the actual execution of these schemes according to the above laws; all the phenomena of nature are thus controlled by these laws and all animate and inanimate objects in nature are bound to obey them, the animals obey them by instinct. (3) The third being the laws concerning humanity given to mankind through revelation, with the difference that human beings are imbued with the faculty of "freedom of choice and will". They are thus given an option whether to obey these laws or not, the result, however, being either construction or destruction according to how the human beings act.

The fact that the law-giver is One and the laws governing the phenomena of nature and those governing the human affairs originate from the same source, and that there is a unity of purpose in the creation of the universe, is described in the Holy Quran over and over again, in so many different ways. That the most obvious and attractive phenomena of nature and the most wonderful capabilities of human personality are all governed from the same source, is beautifully described in the following verses:

وَالشَّمْسِ وَضُحٰهَا ۙ وَالْقَمَرِ اِذَا تَلٰهَا ۙ وَالنَّهَارِ اِذَا جَلّٰهَا ۙ وَالَّيْلِ اِذَا
يَغْشٰهَا ۙ وَالسَّمَآءِ وَمَا بَنٰهَا ۙ وَالْاَرْضِ وَمَا طَحٰهَا ۙ وَنَفْسٍ وَّمَا سَوّٰهَا ۙ فَاَلْهَمَهَا
فُجُوْرَهَا وَتَقْوٰهَا ۙ قَدْ اَفْلَحَ مَنْ زَكّٰهَا ۙ وَقَدْ خَابَ مَنْ دَسّٰهَا ۔ (91.1-10)

"By the sun and its brightness and by the moon as she follows him. By the day as it shows up the sun's glory and by the night as it conceals it. By the heavenly bodies and their (wonderful) structures. By the earth and its (wide) expanse. By the human personality and the order and equilibrium given to it and the (wonderful) way in which the possibilities of its disintegration and protection therefrom have been ingrained therein. All these laws governing the phenomena of nature as well as those that govern the human personality are witness to the fact that truly the one who develops his personality (by his right conduct) does succeed, and the one who disintegrates it by his misdeeds, fails".

Immutability of Divine Laws

The Holy Quran says:

(6:34) ... لَا مُبَدِّلَ لِكَلِمٰتِ اللّٰهِ ...

"Nobody can change the laws of Allah".

Not even the messenger of Allah.

(3:127) ... لَيْسَ لَكَ مِنَ الْأَمْرِ شَيْءٌ ...

"(O Messenger of Allah!) you are not given the authority to change the laws of Allah".

(30:30) ... لَا تَبْدِيلَ لِخَلْقِ اللَّهِ ...

"Allah's process of creation never changes".

(17:77) ... لَا تَجِدُ لِسُنَّتِنَا تَحْوِيلًا ...

"You do not find a change in the working of Our (Divine) laws".

(35:43) ... فَلَنْ تَجِدَ لِسُنَّتِ اللَّهِ تَبْدِيلًا ...

"So you can never find a change in the working of the Divine Laws".

This magnificent proclamation by the Holy Quran, fourteen hundred years ago, when a concept of law hardly existed, now forms the basis of all scientific research and is the essence of قانون مکافات عمل (the law that every effect has got a cause). All the past, present and future scientific research is indebted to this fundamental. All the wonderful adventures in the outer space today are the outcome of a confidence in the immutability of the laws of nature.

Allah's Creation is Perfect

The Holy Quran says:

الَّذِي خَلَقَ سَبْعَ سَمٰوٰتٍ طِبَاقًا مَا تَرٰى فِي خَلْقِ الرَّحْمٰنِ مِنْ تَفٰوُتٍ

فَارْجِعِ الْبَصَرَ هَلْ تَرٰى مِنْ فُطُورٍ ثُمَّ ارْجِعِ الْبَصَرَ كَرَّتَيْنِ يَنْقَلِبْ

(67:3-4) إِلَيْكَ الْبَصَرُ خَاسِئًا وَهُوَ حَسِيرٌ

"It is He Who created several heavens closely fitting one another. No want of proportion will you see in the creation of One Who created things within a specified pattern. So turn thy vision again. Do you notice any flaw? So again turn thy vision a second time; your vision will come back to you dull and discomforted in a state worn out".

Against the background described above, now let us proceed to describe the shape and structure of the universe. The process of creation and allied subjects shall be discussed later.

CHAPTER II

A Bird's Eye View of the Universe

اَلشَّمْسُ وَالْقَمَرُ بِحُسْبَانٍ ۝ وَّالنَّجْمُ وَالشَّجَرُ يَسْجُدٰنِ ۝ وَالسَّمَآءَ
رَفَعَهَا وَ وَضَعَ الْمِيْزَانَ ۝ اَلَّا تَطْغَوْا فِى الْمِيْزَانِ ۝ (55:5-6)

(The Divine laws that operate in the physical world, as well as those given to mankind through revelation, are equally immutable). The sun and the moon follow courses exactly computed. The stars (in the heaven) and the trees (on the earth) are (equally) subjected to the Divine laws. And the celestial bodies He raised high and put them (in space perfectly) balanced. That you may not transgress the limits (O mankind!) prescribed by the Creator for the maintenance of balance (in the human society).

THE SOLAR SYSTEM (FIG. 1)

We are living on the Earth which is a member of the Solar System. It is a system controlled by the sun and contains the planets with their satellites, the comets, meteors, asteroids and inter-planetary material.

The Sun

(78:13) وَّجَعَلْنَا سِرَاجًا وَّهَّاجًا ۝

"And We have made (the sun) the source of heat and light".

Sun is a star round which the earth and other bodies of the solar system revolve. It is a star of an average size, being 864,000 miles in diameter. Its density is only 1.4 times that of water. It is a source of heat and light to the solar system. The life-giving energy of the sun which is generated by the nuclear collision, raises the temperature inside it to about 36 million degrees Centigrade.

The Planets. There are nine major planets in the system and several thousands tiny planets called asteroids. The planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto. Jupiter is the sun's largest dependent planet. Its diameter is roughly 13 times that of the Earth but is no more

Fig. 1 --THE SOLAR SYSTEM.

than a speck by comparison with the sun itself. The sun contains over 99.87 per cent of the entire mass in the solar system. Mercury is nearest to the sun, the average distance being 36 million miles. The planets move at different speeds in separate orbits and varying distances from the sun. So far as it can be said at present, life does not exist on any planet other than the Earth. Mercury is so close to the sun that the temperature on its sunlit side reaches 500°C. Venus though about double the distance from the sun as Mercury, has a surface temperature of 100°C. Of the planets farther than the Earth from the Sun, Jupiter, Saturn, Uranus, Neptune and Pluto are too cold and their atmospheres contain poisonous gases, such as hydrogen, helium and ammonia. It is believed that there is some form of life on the Mars but the air over the planet is very thin and icy, and probably some form of primitive vegetation exists there. Earth is the only member of the sun's family whose composition and distance from the sun has made possible for life to exist.

As far as it is known today, no other planetary system exists in the universe.

Satellites. These are small or secondary planets revolving round the larger ones. They are too small in relation to their mother planets. The moon is the only satellite of a size comparable to its planet, the Earth.

Asteroids. An asteroid is a minor planet, a small world moving round the sun. Most, though not all, asteroids have orbits which lie between the orbits of Mars and Jupiter. Ceres, the largest, has a diameter of 430 miles. The total number of asteroids in the solar system has been roughly estimated as 45,000.

Comets. (الجوارالكنس)

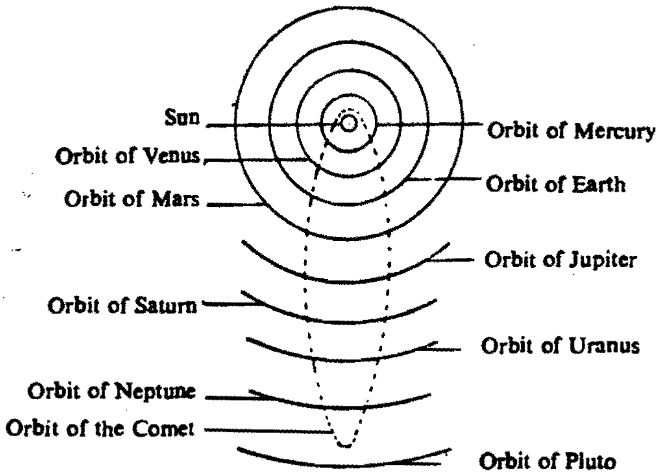


Fig. 2.— ORBIT OF HALLEY'S COMET.

Comet is a member of the solar system moving round the sun in an orbit which is more elliptical than that of a planet. A large comet is made up of relatively small particles surrounded by an envelope of tenuous gas while the tail consists of excessively rarified gas and a fine dust released by solar heat. There are several dozens of known short period comets. Encke's Comet, for instance, has a period of 3.3 years and has been observed at nearly 50 separate returns. The only bright comet with a period less than a century is Halley's (Fig. 2) which takes 76 years to complete one journey round the sun, and was visible last time in 1986. Great comets have been extremely rare of late. It seems that comets are short-lived. The Holy Quran describes it as "الجوارالكنس" (81:16), i.e., the heavenly body that regularly moves in its orbit without any hindrance and still goes into hiding for a long period. ال (the) indicates that it refers to a particular group of heavenly bodies.

Meteors. These are small bodies moving round the sun, in the manner of a dwarf planet. If it enters the upper atmosphere it becomes intensively heated by friction against the air particles and destroys itself in the streak of luminosity known as shooting star. The average shooting star is very small, a few thousandths of a gramme in weight. It is estimated that about 100 million meteors enter the earth's atmosphere daily.

Inter-Planetary (and inter-stellar) matter: It was formerly believed that the space in-between the stars must be empty, but this is now known to be wrong. There is a large quantity of inter-stellar material; much of it is hydrogen, though other substances also occur.

STARS (FIG. 3)

A star is a globe of incandescent gas. The distance between stars is measured by the methods of trignometrical parallax. Beyond a distance of several hundred light years the parallax becomes too small to be measured and alternative methods have to be employed. One such method is to deduce the star's real luminosity by examination of its spectrum, when the distance may be computed.

The stars that we see are so far away from us that when we look at them, we look back deep into the past, for we see them not as they are now but often as they were hundreds of years ago. The light we receive from most of them began its journey long before we were born, and from the more distant ones long before man appeared on the Earth. Even light of the sun, a mere 93 million miles away, takes 8 minutes to reach the Earth; from the nearest star, Proxima Centauri in the Southern hemisphere it takes more than four years. The vast distances in space need a measure longer than a mile. Astronomers use the light year which is the distance travelled by light in one year; the distance travelled in one second being 186,300 miles. In these terms Proxima Centauri is four and a one-third light years away from the Earth. The distance from earth to the bright star Altair is about 16 light years, to Vega 26 light years, to Deneb 1500 light years, while some stars of the milky way are so far distant that their light takes thousands of light years to reach us. The stars are, therefore, placed at great distances in space not only form the Earth but also from one another.

The stars vary greatly in size. Though the Sun seems large to us, it is no more than an average star in the rest of the heavens. Some stars called super-giants make the sun seem a tiny dwarf. Betelgeux, for instance, could contain not only the Sun and the Earth's orbit round it but the entire orbit of the planet Mars -- an orbit of 284

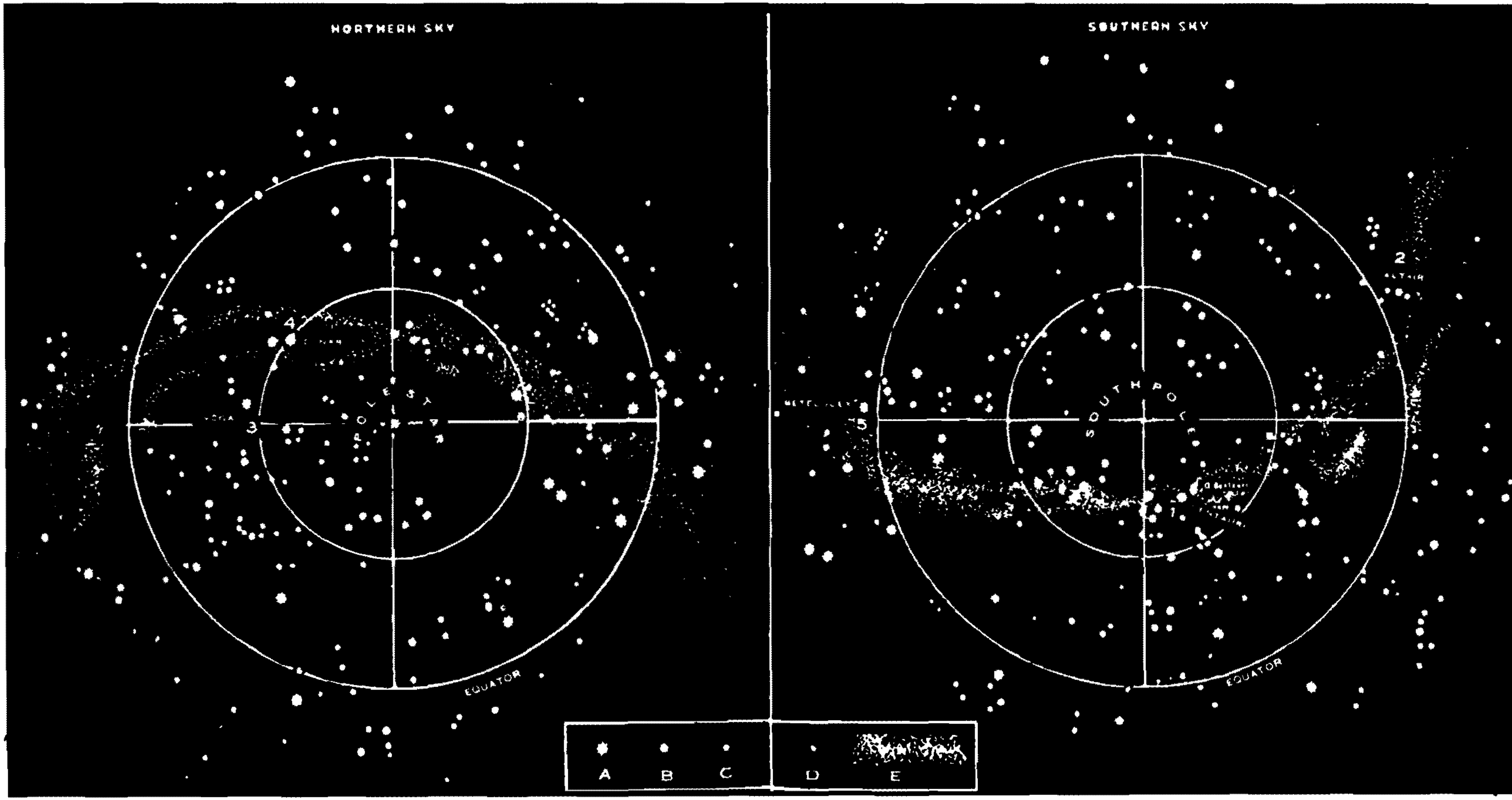


Fig. 3.—THE STARS

1.	Proxima Centauri	-- Distance from the earth 4-1/3 light years
2.	Altair	----- Distance from the earth 16 light years.
3.	Vega	----- Distance from the earth 26 light years.
4.	Deneb	----- Distance form the earth 1500 light years.
5.	Betelgeux	---- A super-giant star.

(A)	Stars of 1st magnitude.
(B)	Stars of 2nd magnitude.
(C)	Stars of 3rd magnitude.
(D)	Stars of 4th magnitude.
(E)	The Milky Way.

million miles in diameter. On the other hand, there are stars which are a few thousandths of the sun's size. Stars vary considerably in brightness and so are graded in different magnitudes. The brightest stars belong to the 1st Magnitude, those slightly less bright to the second, and so on until we reach the sixth magnitude which consists of stars just visible to the naked eye on a very clear night. A star of 1st magnitude is 100 times brighter than a star of the sixth magnitude. Compared with some first-magnitude stars, the sun's light is very faint. The brightest stars in the sky are not necessarily the nearest to us. Several very faint stars are in fact nearer to the earth than the most bright ones.

GALAXY OR STAR SYSTEM (FIG. 4)

The stars are arranged in groups or systems called Galaxies. The galaxy of which the sun with its family of planets is a member, appears to consist of 100,000 million stars, gaseous Nebulae* and an immense quantity of interstellar material. Seen edge-on from outside, the milky way system looks like a fairly flat disc with a thick cloud of stars near and around the centre. Seen at right angles, it looks like a Catherine-wheel with numerous spiral arms of varying size going out from the centre. The sun lies in one of these arms. It is so far away from the centre that it needs about 200 million years to complete one orbit round the "hub" of the Catherine-wheel. Calculated on the basis of the sun's estimated age, it can have made only about 20 complete circuits. The diameter of the galaxy is 1,000,000 light years and the thickness 10,000 light years. The sun lies about 25,000 to 30,000 light years from the galactic nucleus.

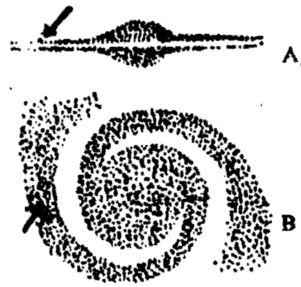


Fig. 4.— THE GALAXY
(*a*) edge on. (*b*) in plan view.
(Arrows indicate position of the Solar System)

Scientific observation has as yet revealed no limits to the universe and has so far probed only a fraction of it, yet to travel to the frontier of that observed fraction, even at the speed of light, would take 6,000 million years. The different bodies and structures in the universe, all of which appear to be receding from us, range from single galaxies to mammoth clusters containing as many as 500 galaxies. Although the cluster of galaxies, to which our galaxy belongs is comparatively small (it has only 14 members), our galaxy itself, the milky way system, ranks among the larger of the known stellar systems. There are thousands of millions of galaxies of varying sizes and structures. The most distant one whose distance has so far been determined with any degree of accuracy, lies perhaps at 5,000 million light years.

*Nebula is a cloud of interstellar matter. It is generally assumed that galactic nebulae are regions in which fresh stars are being created. If a nebula contains suitable stars, it shines either by exertation, by reflection, or by both; if not it shows up as a dark mass blotting out the light of more distant stars.

THE PLANET EARTH THE HOME OF MAN -- ITS STRUCTURE (FIG. 5)

Let us at the outset describe briefly the nature and properties of the materials that make up the Earth's surface. In its original gaseous state, we believe there were only the chemical elements. As these gases cooled down, some elements combined with others, forming compounds, e.g., water is a compound. A simple element or compound found in the earth, but not formed by plants or animals is called a *Mineral* e.g., Quartz -- a mineral, composed of the elements silicon and oxygen. A rock consists chiefly of mixtures of minerals; Granite, for example, is a rock composed of at least three minerals, quartz, feldspar and mica. Some rocks consist of only one mineral, e.g., limestone; it is called a rock because it forms whole areas of the surface of the earth. *Kinds of Rocks* -- We believe that the original gases that formed the earth, cooled down to become liquids first and solids later. Any rock derived from the molten condition, we call it *Igneous*. The loose material carried down by rivers and deposited on the continential shelf as sediment becomes consolidated into rocks: such rocks we call *Sedimentary* rocks. Both these kinds of rocks, igneous and sedimentary, when subjected to the action of water, heat, pressure, movement and other forces, are changed into what we call, *Metamporphic* rocks. The surface layer of the earth in which are situated the continents, oceans and mountains is called the Earth's Crust. It is composed of all the three kinds of rocks--igneous, sedimentary and metamorphic.

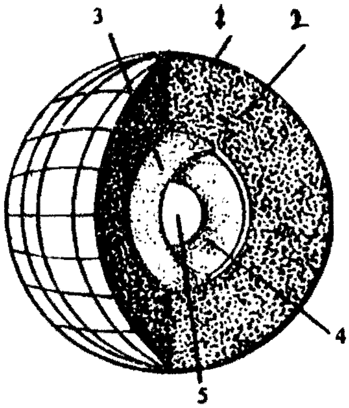


Fig. 5.—CORE OF THE EARTH.

1. Crust. 2. Mantle.
3. Sulphide and Oxide shell.
4. Outer core. 5. Inner core.

The continental parts of the earth's crust are composed of rocks of many different compositions which as a whole have a density and composition of granite. The granite layer is called *Sial* because of the predominance of silica and aluminium in its composition. Underneath the granite layer is a denser layer which has an average density and composition similar to that of the common black volcanic lava known as basalt. The basaltic layer (termed *Sima* because of its richness in magnesium) directly underlines the ocean floor, and here forms the thinnest part of the earth's crust. In continental areas the granite and basaltic layers together reach an average thickness of about three miles.

The best clues to what lies beneath the Earth's exterior are provided by records of earthquake shocks. Shock waves passing through the earth are found to change their direction and speed at certain level which are known as *discontinuities*. The first major discontinuity is at the base of the basaltic layer where the latter rests on the Mantle -- the second layer of the earth. At this level a marked change in the velocity of earthquake waves takes place. This may be due to a change in the chemical nature of the rocks or merely a change in their physical state.

The Mantle extends to a depth of 1,800 miles where a second major discontinuity marks the beginning of Outer Core -- the third layer of the earth. The material near the inner edge of the Mantle is two to three times as heavy as the surface rocks.

The Outer Core is 1,310 miles thick and is probably formed of heavy metals (iron and nickel) in molten form.

The next layer, the Inner-Core or the innermost layer of the earth, 850 miles thick, is believed to consist of the same material as the outer core but in a solid state. Knowledge that the earth could not consist entirely of the surface rocks, came first from the planets' weight measured by its pull of gravity, for these materials are too light to account for a total mass of 6,600 million million million tons.

Movements of the earth's crust. Movements of the earth's crust take place both gradual and sudden. There is much evidence in hand to show that every part of the earth's crust has moved at one time or the other. The finding of the skeleton of a whale in the glacial gravels near Lake Champlain and the remains of other massive animals in the sedimentary rocks of mountains can mean only one thing: these areas were once under sea water. The ancient temple of Jupiter Serapis at Pozzuoli, near Pompeii, is known to have been on dry land A.D. 235. When it was rediscovered in 1749, the bases of its remaining upright columns were buried in marine sediments to a depth of twelve feet above the floor of the temple.

Some of the changes in the earth's crust must have been due to sinking of the ocean bottom, which would permit the water to run off the land; others to the accumulation of vast amounts of sediment, eroded from the land and deposited in the sea, which would cause the water to overflow the land; still others to a glacial epoch, which precipitated the water, evaporated from the ocean, as snow instead of water. It has been estimated that if the ice sheets of the earth today were all melted, it would raise the level of the oceans about 80 feet. There have been many times when entire continents were uplifted or depressed.

The theory of Isostasy. The cause of the periodic uplift and depression is said to be as follows:-- The sediments eroded from the mountains are deposited by rivers on the continental shelf. This causes the removal of the load from the land segment which becomes lighter; on the other hand it makes the ocean segment heavier. The rock underneath the crust is solid but very hot; and there is reason to believe that it is plastic. Thus a slow adjustment takes place, pushing down the ocean segment and forcing up the granite land segment. This re-elevation of land segment is again followed by erosion and thus a cycle of its uplift and depression continues.

Besides these movements of the earth's crust which are usually imperceptible, requiring millions of years, there are rapid movements which originate from the forces that work in the depths of the earth's interior. The constant movements in the depth of the earth mount in intensity from time to time, culminating in *Orogenies*, profound disturbances in the earth's crust, which give rise to great mountain ranges. The early stage of an orogeny is down-warping of the crust and formation of a sea-filled basin in which great thicknesses of sedimentary rock accumulate. Later the sides of the basin gradually move towards each other and the bottom moves up. The sedimentary rocks caught in this vice are folded and slid over each other piling up into a great mountain chain. The fractures along which the sliding takes place are called *Thrusts* or *Thrust Faults* (Fig. 6). Heat and pressure in the depths of the down-warp -- the roots of the mountain range -- metamorphose the sedimentary rocks and allow molten granite rocks to form. This rises under great pressure, either crystallizing on the way up to give 'intrusions' or drilling an outlet in the Earth's surface to pour as volcanic lava and ashes. As soon as the folded rocks

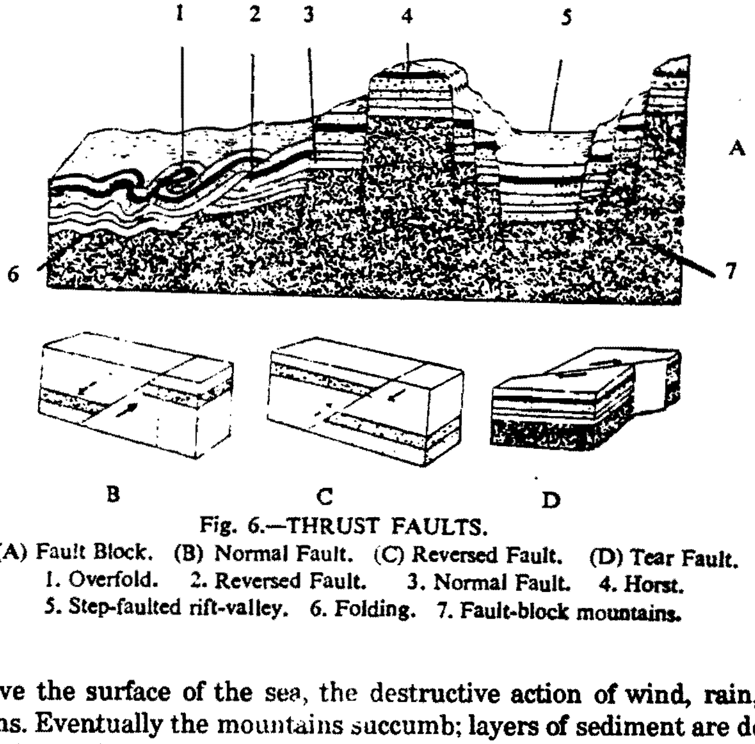


Fig. 6.—THRUST FAULTS.
(A) Fault Block. (B) Normal Fault. (C) Reversed Fault. (D) Tear Fault.
1. Overfold. 2. Reversed Fault. 3. Normal Fault. 4. Horst.
5. Step-faulted rift-valley. 6. Folding. 7. Fault-block mountains.

appear above the surface of the sea, the destructive action of wind, rain, frost and waves begins. Eventually the mountains succumb; layers of sediment are deposited in places over the eroded rocks and a surface of low relief with meandering rivers is all that is left.

Thus in the jig-saw of rocks that form the earth's surface, the pieces are slowly and endlessly being rearranged.

HOW THE UNIVERSE CAME INTO EXISTENCE

In the words of Sir Eddington, "We can have no conception how it all began in the past. But at some stage we imagine the void to have been filled with matter rarefied beyond most tenuous nebulae, the atoms sparcely strewn hither and thither in formless disorder. Then gradually the power of gravitation is felt. Centres of condensation begin to establish themselves and draw in other matter. The first partitions are star systems, such as our galactic system. Sub-condensations separate the star clouds or clusters; these divide again to give the stars. This process of evolution has not reached the same development in all parts. We observe nebulae and clusters in different stages of advance. Some stars are still highly diffused, others are concentrated like the sun with density greater than water; others, still more advanced, have strunk to unimaginable density. But no doubt can be entertained that the genesis of the stars is a single process of evolution which has passed and is passing over a primordial distribution.

Formerly it was speculated that the birth of a star was an individual event, like the birth of an animal. From time to time, two long extinct stars would collide and be turned into vapours by the energy of the collision; condensation would follow and life as a luminous body would begin all over again. We can scarcely affirm that that shall never occur and that the sun is not destined to have a second or third innings; but it is clear from the various trends among the stars that the present stage of existence of the sidereal universe is the first innings. Groups of stars are formed which move across the sky with common proper motion; they must have had a single origin and cannot have been formed by casual collision.

Formation of Planetary System. As far as our present knowledge goes, our planetary system is unique in the universe, though it may be difficult to assume that nowhere else in the universe has nature repeated the strange experiment which she has performed on the earth.

On examining the stars with a telescope we find that a good number of stars which appear single to the eye are actually two stars close together. When telescope fails to separate them, the spectroscope often reveals two stars in orbital revolution round each other. At least one star in three is double. The most obvious cause of division of stars is excessive rotation. As the gaseous globe contracts, it spins faster, until a time may come when it can no longer hold together and some kind of relief must be found. It has been assumed that the planetary system has come into existence in a similar way. According to the Nebular hypothesis of Laplace, the sun gained relief by throwing off successively rings of matter which have formed the planets. It might be held that the ejection of a planetary system and the fission into a double star are alternative solutions of the problem arising from excessive rotation, the star taking one course or the other according to circumstances. But we know myriads of double stars and of only one planetary system; but in any case it is beyond our power to detect other planetary systems if they exist. Research work by other scientists indicates that rotational break up produces a double star and never a system of planets. The solar system is not a typical product of development of a star; it is not even a common variety of development, it is a freak.

By elimination of alternatives, it appears that a configuration resembling the solar system would only be formed if at a certain stage of condensation an unusual accident had occurred. According to Jeans the accident was the close approach of another star casually pursuing its way through space. This star must have passed within a distance not far outside the orbit of Neptune; it must not have passed rapidly but have slowly overtaken or been overtaken by the sun. By tidal distortion it raised big protuberances on the sun and caused it to spurt out filaments of matter which have condensed to form planets. This was long time ago. The intruding star has since gone on its way and mingled with the others; its legacy of a system of planets remains, including a globe habitable by man". (The Nature of the Physical World).

According to the evolutionary theory all the material in the universe was formerly concentrated in what may be termed a '*Primeval Atom*', so that the universe was created at one particular moment and will eventually die. Supporters of the steady state theory, on the other hand, maintain that the universe has always existed and will exist for ever and that fresh matter is continuously being formed. Present observational evidence seems to favour the former hypothesis rather than the latter.

As regards the origin of the universe, the Holy Quran declared fourteen hundred years ago:

أَوَلَمْ يَرَ الَّذِينَ كَفَرُوا أَنَّ السَّمٰوٰتِ وَالْأَرْضَ كَانَتَا رَتْقًا
فَفَتَقْنٰهُمَا ۖ وَجَعَلْنَا مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ ۖ أَفَلَا يُؤْمِنُونَ ○ (21:30)

"Do not the unbelievers see that the heavenly bodies and the earth were joined together (as one unit of creation), before We clove them asunder? And We made from water every living thing: will they not believe?"

The Scale of Time. The creation of man started about one million years ago while the existence of the earth is estimated to be 5,000 million years. The sun must have been burning still longer, living on its own matter which dissolves bit by bit into radiation. So tremendous is the radiation rate of the sun's energy that it loses some four million tons in weight every second. According to the theoretical time scale which seems best supported by astronomical evidence, the beginning of sun as a luminous star must be dated five billion (5.10^{12}) years ago. On the other hand, despite the tremendous rate of loss on account of radiation , it may continue as a star of increasing feebleness for at least another 16,000 million years. The theory of subatomic energy has prolonged the life of a star from millions to billions of years and we may speculate on processes of rejuvenation which might prolong the existence of the sidereal universe from billions to trillions of years.

RECESSION

As already described, to begin with the Earth and the celestial bodies were all one mass and later broke into pieces. (21:30). At a still later stage the solar system which was one compact mass,got separated into the sun (the main mass) and the planets. The most obvious cause of it being the excessive rotation of the sun which gained relief by the separation and recession of the planetary pieces, the Earth being one of them. The Holy Quran says:

(79:30) وَالْأَرْضَ بَعْدَ ذَٰلِكَ دَحَاهَا ۝

"And after that We threw out the Earth".

This process of recession still continues as far as the galaxies are concerned. The spectra of galaxies show red-shifts which means that there is an apparent shift of all the spectral lines towards the red or long wave end of the spectrum. This indicates motion of RECESSION. It seems that each group of galaxies is moving away from each other group, so that the entire observable universe is expanding. The only galaxies which are not racing away from us are those of the local group. It has been found that the farther away the galaxies are, the greater is their velocity of recession. The scientists have observed only recently that the universe is expanding. It is marvellous that the holy Quran pointed out towards this fact 1400 years earlier when it was said:

(51:47) وَالسَّمَاءَ بَنَيْنَاهَا بِأَيْدٍ وَإِنَّا لَمُوسِعُونَ ۝

"With power and skill, We did construct the heaven. Verily We are expanding it".

THE BALANCE (ميزان)

The stars and the extrastellar bodies in a galaxy, or the members of a group of galaxies, are held together by the pull of gravity. Gravitation is the universal attraction of every particle of matter for every other particle; the force is proportional directly to the product of the masses of bodies and inversely to the square of distance between them. For example, in the solar system, the sun by its pull of gravity keeps the planets under control, in spite of their comparative smallness and the enormous distances that separate them from the sun and from one another. Similarly the sun and the other 100,000 million stars belonging to the Milky Way are kept under control by the galactic nucleus.

The relative position of a group of celestial bodies, say for instance, the solar system, is kept steady by means of two forces. Firstly, the pull of gravity on account of which the planets are pulled towards the sun and secondly the speed with which these planets move round the sun. These centrifugal (force pulling away from the centre) and centripetal (force pulling towards the centre) forces, are so balanced that they keep the relative position of the sun and the planets steady. Thus the celestial bodies with billions of tons of weight are kept in position without any visible pillars. The Holy Quran says:

(13:2) اَللّٰهُ الَّذِىْ رَفَعَ السَّمٰوٰتِ بِغَيْرِ عَمَدٍ تَرَوْنَهَا ثُمَّ اسْتَوٰى عَلَى الْعَرْشِ ...

> "Allah is One Who raised the celestial bodies without any visible pillars and is established on the throne of authority".

(31:10) خَلَقَ السَّمٰوٰتِ بِغَيْرِ عَمَدٍ تَرَوْنَهَا ۔

> "He created the heavenly bodies without any pillars that you can see".

(55:7) وَالسَّمَآءَ رَفَعَهَا وَوَضَعَ الْمِيْزَانَ ۙ

> "The celestial bodies He has raised high and He has set up a balance (in between them)".

The Holy Quran introduces this mathematical balance maintained between the heavenly bodies, as a guidance for mankind and asks human beings to act justly to each other and to observe balance in all their actions and never to tansgress due balance in anything.

(55:8) اَلَّا تَطْغَوْا فِى الْمِيْزَانِ ۝

> "In order that you may not transgress (due) balance".

Just as a small imbalance between the centrifugal and centripetal forces may be the cause of destruction of a system of heavenly bodies, so does an injustice in the human affairs disrupts the smooth running of the human society.

THE ORBITS

The movement of any star or a planet takes place in a definite orbit around its gravitational nucleus. For example, in the case of solar system the gravitational nucleus is in the sun, and the planets revolve round the sun in their respective orbits with an utmost precision (Fig. 2).

Actually the orbits of the planets are elliptical. The closer a planet is to the sun, the faster it moves. For instance, Mercury, at an average distance of 36 million miles from the sun, moving at a speed of 30 miles per sec., takes 88 days to revolve round the sun; while the Earth the average distance of which from the sun is 93

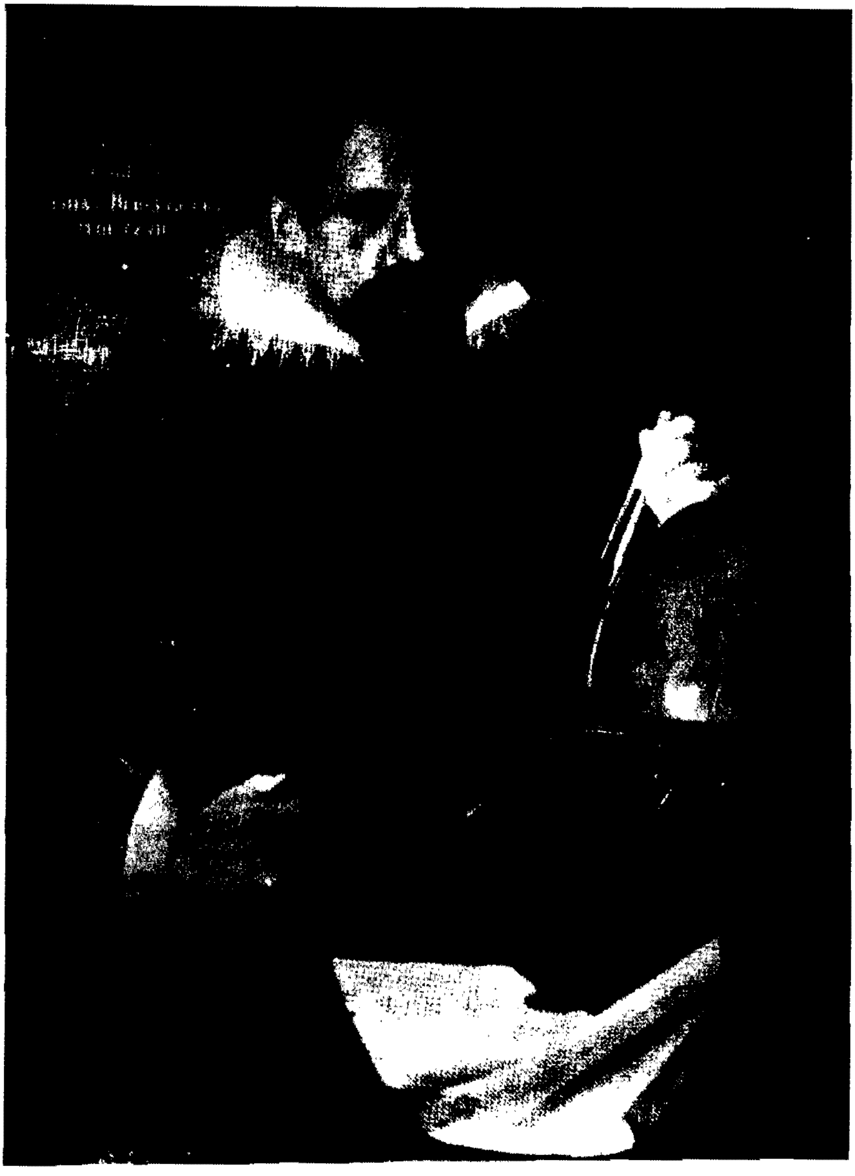


Fig. 8. JOHANNES KEPPLER

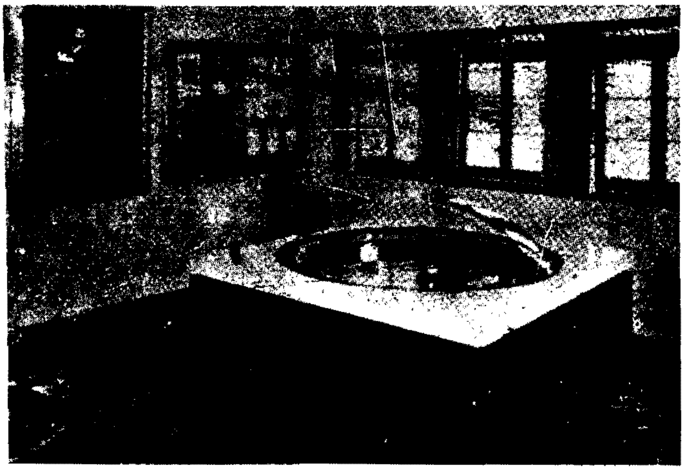


Fig. 9. KEPPLER'S HOUSE.
(Model showing laws of planetary motion, is at the bottom)

million miles, needs exactly one year to complete its orbit, travelling at a speed of 18.5 miles per second. Pluto, the most distant known planet about 3666 million miles from the sun takes 248 years, moving at a speed of mere 3 miles per second. The German astronomer Johannes Keppler, (Fig. 8) first gave the laws of planetary motion between the years 1609 and 1619 A.D. The Astronomia Nova published in 1609 is Keppler's most important work. Keppler concluded after painstaking calculations that the principles concerning the movement of the planets which had been recognised since the time of Aristotle should be abandoned. They do not revolve round the sun in circular orbits but in elliptical orbits and their velocity is not constant over the entire course. Keppler succeeded in establishing the laws of planetary motion which were in complete accordance with the observations which had been made. The laws are as follows:

(1) The orbits of the planets are elliptical, the sun lying at one of the faces of the ellipse.

(2) The radius vector i.e., the line joining the centre of the planet to the centre of the sun sweeps out equal areas in equal times.

(3) The square of the revolution periods of any two planets are proportional to the cubes of their mean distance from the sun.

Fig. 9 shows Keppler's House, with Model showing laws of planetary motion.

The planets not only move in their respective orbits round the sun but also each one undergoes an axial rotation around its own axis. Take for example the moon. The moon is generally regarded as earth's satellite but on the whole it seems preferable to term the earth-moon system a double planet. The orbit of the moon is markedly elliptical and is always concave to the sun. The distance from the Earth ranges between 221,460 miles perigee (point in the orbit of moon or planet which is nearest to the earth) and 252,700 miles apogee (point in orbit of moon or planets farthest from the earth), the range giving a mean of 238,840 miles. The revolution period is 27 days, 7 hours and 43 minutes, and this is also the period of axial rotation. But since the rotational period is constant, while the velocity in orbit changes (see Keppler's laws of planetary mission; which apply to a planet and its companion, as well as to a planet in relation with the sun), the position in the orbit and the amount of rotation become regularly 'out of step'; the moon seems to rock very slowly to and fro, uncovering first one limb and then the other.

The Holy Quran says:

وَالْقَمَرَ قَدَّرْنٰهُ مَنَازِلَ حَتّٰى عَادَ كَالْعُرْجُوْنِ الْقَدِيْمِ ۝ (36:39)

"And the moon, We have measured for her its stages, till she returns like the old (and withered) lower part of date stalk".

The Holy Quran described the movements of the planets and the stars in those dark ages when people mostly believed the earth to be stationary. The Holy Quran described the earth as a cradle i.e., an object which regularly moves and at the same time provides ease and comfort:

أَلَمْ نَجْعَلِ الْأَرْضَ مِهٰدًا وَّالْجِبَالَ أَوْتَادًا ۝ (78:6-7)

"Have We not made earth a cradle and the mountains as pegs".

خَلَقَ السَّمٰوٰتِ بِغَيْرِ عَمَدٍ تَرَوْنَهَا وَأَلْقٰى فِي الْأَرْضِ رَوَاسِيَ أَنْ تَمِيْدَ بِكُمْ (31:10)

"He created the celestial bodies without pillars that you can see. He set on the earth mountains standing firm, so that (the earth) moves with you".

As regard the orbits the Holy Quran says:

وَهُوَ الَّذِيْ خَلَقَ الَّيْلَ وَالنَّهَارَ وَالشَّمْسَ وَالْقَمَرَ ۭ كُلٌّ
فِيْ فَلَكٍ يَّسْبَحُوْنَ ۝ (21:33)

"It is He Who created the night and the day and the sun and the moon. All (heavenly bodies swim along, each in its orbit."

The movement inside the respective orbits is so accurately timed that the heavenly bodies do not collide with one another:

لَا الشَّمْسُ يَنْۢبَغِيْ لَهَآ أَنْ تُدْرِكَ الْقَمَرَ وَلَا الَّيْلُ سَابِقُ
النَّهَارِ ۭ وَكُلٌّ فِيْ فَلَكٍ يَّسْبَحُوْنَ ۝ (36:40)

"It is not permitted to the sun to overtake the moon, nor can the night outstrip the day. Each (just swim along in (its own) orbit".

So accurate are the movements of the heavenly bodies that we base the calculation of time on the position of the sun and the moon in their respective orbits:

هُوَ الَّذِيْ جَعَلَ الشَّمْسَ ضِيَاۗءً وَّالْقَمَرَ نُوْرًا وَّقَدَّرَهٗ مَنَازِلَ لِتَعْلَمُوْا
عَدَدَ السِّنِيْنَ وَالْحِسَابَ ۭ مَا خَلَقَ اللّٰهُ ذٰلِكَ اِلَّا بِالْحَقِّ ...

(10:5)

"It is He Who made the sun, the source of light and the moon a reflected light and measured out stages for her that you may know the number of years and the count (of time). This is nothing but a part of His constructive design".

فَالِقُ الْإِصْبَاحِ وَجَعَلَ الَّيْلَ سَكَنًا وَّالشَّمْسَ وَالْقَمَرَ حُسْبَانًا ... (6:97)

"It is He Who cleaveth the daybreak (from the dark). He made the night for rest and tranquillity and the sun and the moon for the reckoning (of time)".

Our calendars are mostly based on the relative position of the earth and the sun and the consequent seasonal incidence on the earth. There are, however, other phenomena on the earth whose reckoning of time, coincides with the movements of the moon. For instance, the human fetal life coincides with the lunar months. The stay of a normal human fetus inside the mother's uterus is 280 days i.e., ten lunar months. As already stated, the revolution period of moon is about 28 days and same is the period of menstrual cycle in a woman. The tidal waves of the sea are well known to be related to the movements of the moon.

CHAPTER III

The Well -- Guarded Roof

(The defensive mechanism in سَمَاءَ الدُّنْيَا *the nearer heaven which protects life on the earth).*

وَجَعَلْنَا السَّمَاءَ سَقْفًا مَّحْفُوظًا ۖ وَهُمْ عَنْ آيَاتِهَا مُعْرِضُونَ ۝ (21:32)

"And We have made the heaven as a roof well guarded, yet do they turn away from the signs which these things (points to)".

In the above-said verse the Holy Quran points out that the heaven surrounding the earth is a well guarded roof which protects life on the earth. It is one of the most conspicuous signs which impresses upon man that the working of the physical laws as well as the laws given to mankind through revelation, originate from the same source. Yet the non-believers instead of pondering over this significant sign, turn away from it.

At yet another place it is said:

وَزَيَّنَّا السَّمَاءَ الدُّنْيَا بِمَصَابِيحَ وَحِفْظًا ۚ ذَٰلِكَ تَقْدِيرُ الْعَزِيزِ الْعَلِيمِ ۝ (41:12)

> "And We adorned the lower heaven with lamps and (provided therein) Guards. Such are the measures of One Whose might and knowledge are boundless".

To begin with let us clarify the words سَمَاءَ الدُّنْيَا. Literally it means the heaven surrounding our earth. But the question arises how far it extends? Does it mean the atmosphere surrounding our earth? Or does it mean the heaven which encloses our solar system? Or does it include the far away heaven of which stars are visible to us?

The Quran says:

الَّذِي جَعَلَ لَكُمُ الْأَرْضَ فِرَاشًا وَالسَّمَاءَ بِنَاءً وَأَنزَلَ مِنَ السَّمَاءِ مَاءً ... (2:22)

> "We have made the earth your floor and the heaven your roof and sent down rains from the heaven".

In the above said verse the word سماء comprises only trophosphere from which the rain falls down and which extends only seven miles above the surface of the earth. And in the verse (41:12) it is said وزينا السماء الدنيا بمصابيح. "We adorned سماء الدنيا with lamps". What is meant by lamps? Do they mean the stars which are billions of miles away from the earth? Because in that case, سماء الدنيا shall extend very far away from us. Or do they mean the planets and their satellites which are members of the solar system? The Quran clarifies itself by presenting a subject in different contexts. Thus it is said:

(37:6) إِنَّا زَيَّنَّا السَّمَاءَ الدُّنْيَا بِزِينَةٍ الْكَوَاكِبِ

"We have indeed decked the near heaven with beauty in 'Kwakib'.

Here the word كواكب (plural of كوكب) is used instead of مصابيح which only mean lamps or luminaries. What is meant by the word كواكب ? The meaning of this word has been clarified in still another verse:

اَللّٰهُ نُوْرُ السَّمٰوٰتِ وَالْاَرْضِ مَثَلُ نُوْرِهٖ كَمِشْكٰوةٍ فِيْهَا مِصْبَاحٌ
(24:35) اَلْمِصْبَاحُ فِيْ زُجَاجَةٍ اَلزُّجَاجَةُ كَاَنَّهَا كَوْكَبٌ دُرِّيٌّ...

"Allah is the light of the heavens and the earth. The parable of His light is as if there were a niche and within it a lamp. The lamp is enclosed in a glass. The glass is as if it were a brilliant, كوكب glittering like a pearl".

It is said further in this verse that it is on account of this glass that it becomes "light upon light". The Quran has thus made it abundantly clear that 'Kawakib' are those heavenly bodies which reflect light like glass and such heavenly bodies which send reflected light on the earth are none but planets.

Meaning of the word سَبْعَ (seven)-

The word سَبْعَ Sabaa, as used in the verse (41:12) above is metaphorical. It does not indicate an exact number but gives an undefined idea of plurality. It is not possible to explain this figure in the present state of our knowledge, because the scientific observation has not revealed, so far, any limits to the universe; and as such our knowledge of the outer space is limited. Lane has mentioned with reference to Bezawi that Arabs use the word seven for plurality. Even in Urdu language certain numbers are used for plurality and they do not indicate an exact number. For example میں تمہیں بیس مرتبہ کہہ چکا ہوں۔ "I have told you twenty times". میں تمہیں سینکڑوں مرتبہ کہہ چکا ہوں۔ "I have told hundred times". سات سمندروں پار "Beyond the seven seas", which only mean a long distance.

The word سَبْعَ occurs at various other places in the Holy Quran, in the same sense.

For instance:

(78:12) وَبَنَيْنَا فَوْقَكُمْ سَبْعًا شِدَادًا ۙ

"We have built over you many strong heavens".

(67:3) اَلَّذِىْ خَلَقَ سَبْعَ سَمٰوٰتٍ طِبَاقًا ۔

"It is He who has created a number of heavens, closely fitting each other".

(71:15) اَلَمْ تَرَوْا كَيْفَ خَلَقَ اللّٰهُ سَبْعَ سَمٰوٰتٍ طِبَاقًا ۙ

"'Do you not see, Allah has created a number of heavens, closely fitting one another".

(23:17) وَلَقَدْ خَلَقْنَا فَوْقَكُمْ سَبْعَ طَرَآئِقَ ...

"And We have made above you many tracts".

GUARDS

The other conspicuous word in the verse (41:12) is "guards". Before we consider what these guards are and how they protect life on the earth, let us describe briefly the various physical factors involved in this phenomenon. As shall be described later, the sun's rays consist of high energy radiation such as X-rays and Ultraviolet Rays and low energy radiation such as Heat and Light Rays. High energy radiation is dangerous to life and low energy radiation up to a certain limit is essential for the maintenance of life. When the sun's radiation reaches nearer to the earth, it is disposed of in three different ways: (a) by reflection (b) by transmission and (c) by absorption. In general, gases are the best transmitters, liquids the best reflectors and solids the best absorbers.

Heat transfer. As regards heat there are three modes of its transfer-- (a) conduction, (b) convection and (c) radiation.

Conduction. When a solid is heated at one end, the motion of the molecules increases, they bombard neighboring molecules and give up some of their motion to them. Thus the increased molecular motion which we feel as heat is carried from one end to the other. This is known as conduction. Since increased heat means increased molecular motion, heat causes substances to expand.

Convection. It can take place only in liquids and gases. When a vessel of water is heated from below, the molecules at the bottom of the vessel move more vigorously. The liquid expands and becomes less dense so that an equal volume of colder liquid weighs more than the warmer liquid. The colder heavier liquid drops down and pushes the warmer liquid up. In this way the colder liquid becomes warmer in turn, until the entire contents are warmed. The continuous movement of the warm and cold portions of the liquid creates a convection current. Convection in air is analogous to convection in liquids.

Radiation. It is quite different from conduction and convection; whereas these two can occur only in material medium, radiation can pass through space which is devoid of matter. Conduction and convection are slow but radiation is instantaneous. For example, if we burn up fire in a room it gets warm immediately by heat radiation. On the other hand, with a steam heating system it may take an hour or more for a room to get warm by convection currents. A body radiates heat to every other body which is cooler than itself whether it is in contact with it or not, but conduction and convection currents can take place only between bodies which are in contact with each other.

How the atmosphere is heated. Dense air absorbs more heat than rare air. Carbon dioxide, water vapour and dust absorb heat better than air. When radiation passes through atmosphere, very little is absorbed by its upper layers. As it penetrates farther and farther into the denser, dustier and moister air, more and more of it is absorbed and the air is more and more heated. The air at the bottom is heated not only because of the greater absorbing power of the lower layers but also because of their contact with the warmer land and water surfaces. The heated air expands and rises, the cooler, heavier air above sinks and takes its place. Thus the entire mass of air gets mixed up by convectional currents.

Now let us proceed to describe the term حِفْظًا (Guards) as it occurs in the Holy Quran. The earth's atmosphere is a blanket of gases surrounding the planet. It enables life to exist on the earth, not only because it contains oxygen so essential to life but also because it provides a protective insulation to the earth. Without this insulation, the temperature would have swung from unbearable cold at night to unbearable hot during the day. Just compare it with the moon which is without an atmosphere. There the day temperature rises to 100°C, as high as that of boiling water; and at night the temperature sinks down to-180°C, as low as that of liquid air. Under these conditions no life can exist.

The earth's atmosphere probably extends at least one thousand miles from the surface of the earth. The air is not a uniform mass but can be divided into layers, each with its own characteristics (Fig. 7). The lowest strata of atmosphere is called *Trophosphere*. It extends up to seven miles above the surface of the earth. The convectional currents in the atmosphere take place only in this region. It may thus be described as the region of clouds and weather. The temperature rises steadily from about 15°C (in temperate zones) at sea level, to about 56°C at seven miles, while the air thins out with the increasing height.

Above this, is a ten miles thick layer of *Stratosphere*. The temperature is more or less uniform in this region and is about 60°C. This is because there is no mixing up of air contents by convection. Thus the gases are supposed to exist in strata. Hence the name stratosphere. At its lower boundary the effects of earth's weather are not usually felt.

Above this layer is the layer of *Chemosphere*, which is 20-30 miles thick. It is mainly an accumulation of ozone gas which is a form of oxygen. When ultraviolet rays are passed through oxygen, ozone is formed, but it is changed back to oxygen by water vapours. The absence of water the in Chemosphere has an important effect on the amount of ozone and in this turn has important effects on the amount of high energy solar radiation received on the earth. Ozone acts in both ways. It protects the earth from high energy solar radiation and prevents the earth radiation to pass out which role is also performed by carbon dioxide. The temperature of Chemosphere is very high as compared with the layers above and below it.

Above this, is the layer of *Ionosphere* which extends for about 250 miles above the surface of the earth. In the Ionosphere the air particles are electrically charged (ionised) by the sun's ultraviolet radiation and congregate in four different layers, D, E, F1 and F2. It is these layers which reflect radio waves back to the ground. The temperature increases rapidly from 73°C at the D (lowest) layer to about 1600°C at 200 miles. It is mainly at the lower Ionosphere that meteors from the outer space burn up as they meet the increased air resistance. As already stated, when a meteor enters the Ionosphere it becomes intensely heated by friction

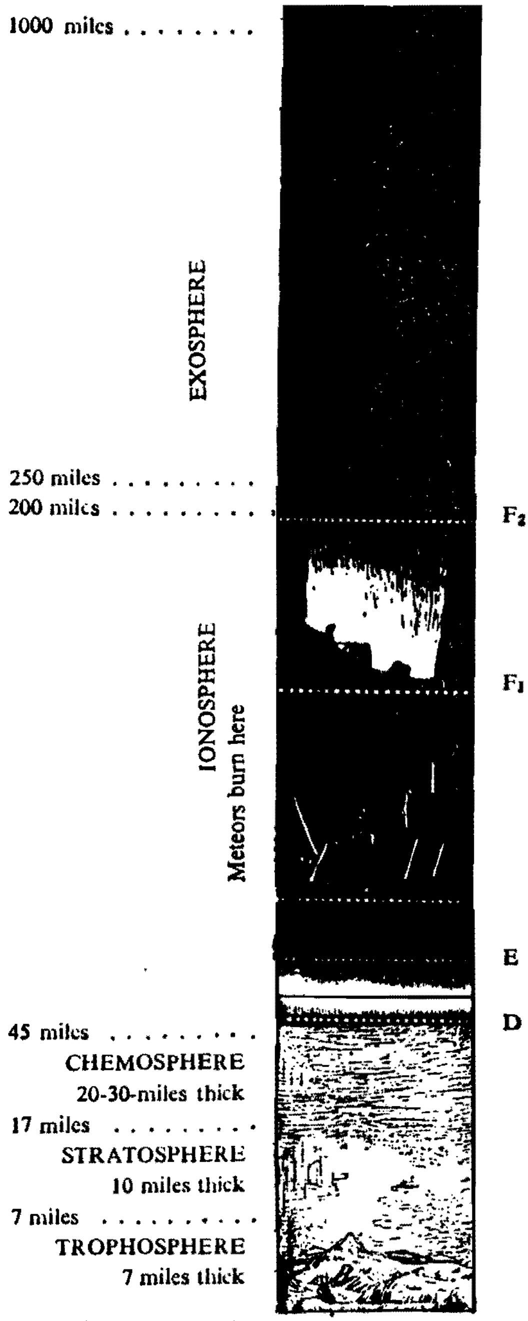


Fig. 7. EARTH'S ATMOSPHERE (GUARDS حفظا)

against the air particles and destroys itself in the streak of luminosity, known as shooting star. It would have been harmful to life on the earth, if it could pass through the atmosphere. Relatively large bodies known as meteorites, however, are able to complete the journey to the ground without being destroyed, but major falls are rare and there is no authenticated record of any one having been killed by a meteorite.

Cosmic rays are fast moving particles continually entering the upper atmosphere from interplanetary space. Mostly they come from far beyond the solar system and their origin is uncertain. They are extremely penetrating and the heavy primaries may well be dangerous to living matter, but the primaries do not reach the Earth's surface. They collide with nuclei of atoms in the Ionosphere and yield the harmless secondary cosmic rays.

Above the Ionosphere is the outermost layer of atmosphere known as *Exosphere*. The air in this layer is so rarified that its density is only one million-millionth of that at the ground level. Air particles move freely, some escaping into the near-vacuum of outer space.

From the above it becomes clear that the 'guards' (حِفْظًا) as described in the Holy Quran are the various factors involved in the protection of life on the Earth and these are distributed in the different layers of the Earth's atmosphere. Ionosphere forms the first line of defence which guards against the harmful effects of radiation from the solar system and of the cosmic rays which come from beyond the solar system. It serves as a filter through which only those rays of the sun are allowed to pass which serve to maintain life on the earth. Meteors which are members of the solar system itself, also burn up here. Chemosphere is the second line of defence which protects against the excessive heat of solar radiation. Trophosphere is the third line of defence. It serves to provide a protective insulation against the excessive rise and fall of temperature.

According to the Holy Quran the protection is provided against شَيَاطِين -- 'rebellious forces'.

وَلَقَدْ زَيَّنَّا السَّمَاءَ الدُّنْيَا بِمَصَابِيحَ وَجَعَلْنَاهَا رُجُومًا
(67:5) لِّلشَّيَاطِينِ وَأَعْتَدْنَا لَهُمْ عَذَابَ السَّعِيرِ

> "We have adorned the nearer heaven with lamps and have made it as missiles to drive away the destructive forces and We have prepared for them the obstacle of fire".

The word شياطين (root ش ط ن) means rebellious forces, which may be forces of nature as mentioned in the above said verse, (or the baser sentiments of man himself). As a matter of fact, all forces of nature are rebellious unless they are tamed or bound by measures. For example, an untamed river is rebellious but a river with boundaries raised on its banks becomes beneficial or an asset for mankind.

The arrangement of the lines of defence, one behind the other in order to protect against the rebellious forces, is described as follows:

وَالصّٰٓفّٰتِ صَفًّا ۙ فَالزّٰجِرٰتِ زَجْرًا ۙ فَالتّٰلِيٰتِ ذِكْرًا ۙ اِنَّ اِلٰهَكُمْ لَوَاحِدٌ ۙ
رَبُّ السَّمٰوٰتِ وَالْاَرْضِ وَمَا بَيْنَهُمَا وَرَبُّ الْمَشَارِقِ ۙ اِنَّا زَيَّنَّا السَّمَآءَ
الدُّنْيَا بِزِيْنَةِ ِۨ الْكَوَاكِبِ ۙ وَحِفْظًا مِّنْ كُلِّ شَيْطٰنٍ مَّارِدٍ ۚ (37:1-7)

"By the forces that range themselves in ranks and are so strong in repelling (the opposite ones). And thus proclaim the divine law. Verily, your Allah is One. He is the Sustainer of the heavenly bodies and the earth and all that is between them and provides sustenance at every point of the rising sun. We have indeed decked the nearer heaven with beauty in the planets and have provided guards against all the rebellious forces.

It is said further:

لَا يَسَّمَّعُوْنَ اِلَى الْمَلَاِ الْاَعْلٰى وَيُقْذَفُوْنَ مِنْ كُلِّ
جَانِبٍ ۙ دُحُوْرًا وَّلَهُمْ عَذَابٌ وَّاصِبٌ ۙ اِلَّا مَنْ
خَطِفَ الْخَطْفَةَ فَاَتْبَعَهٗ شِهَابٌ ثَاقِبٌ ۙ (37:8-10)

"The rebellions forces can not strain their ears in the direction of divine planning; and become cast away from every side. repulsed for they undergo perpetual obstacle. But such, as stealthily dart away (e.g., meteors), are pursued by a flaming fire of piercing brightness".

It means that although these rebellious forces try to find their way in, as it is consistent with their nature; yet they are unable to pass the barrier that lies against them by divine planning and adjustment.

"The word ملا الاعلی used in the verse (37:8) above is translated as the Highest Assembly". It means the Alam-e-Amar where tasks are assigned to the forces of nature.

The strata of earths atmosphere described above, which serve as guards to protect life on the earth, against the rebellious forces of Cosmic rays, Gamma rays X-rays, Ultraviolet rays, excessive heat and light rays, as well as metrors, are called بروج by the Holy Quran. 'Burooj' means forts or fortified spheres. Thus it is said:

وَلَقَدْ جَعَلْنَا فِي السَّمَآءِ بُرُوجًا وَّزَيَّنّٰهَا لِلنّٰظِرِيْنَ ۝ وَحَفِظْنٰهَا مِنْ
كُلِّ شَيْطٰنٍ الرَّجِيْمِ ۝ إِلَّا مَنِ اسْتَرَقَ السَّمْعَ فَاَتْبَعَهُ شِهَابٌ مُّبِيْنٌ ۝
(15:16-18)

"It is He who has set out in the sky fortified spheres and made it fair seeming to beholders. And We have guarded it from rebellious forces. But any that steals hearing (i.e., stealthily and silently darts away without being heard) is pursued by a clear flame of fire".

Our non-scientist commentators, while explaining the above said verses, have related preposterous stories of some sooth-sayers who used to listen to the working of the 'highest Assembly. They interpret the word استرق السمع "steal hearing" (15:18) as 'overhearing which is not correct. Supposing A speaks and B overhears. In that case B steals the voice of A not his hearing.

Fortified Spheres. Amongst various other sign, the Holy Quran also describes the phenomenon of fortified spheres in the nearest heaven (i.e. in Solar System), in support of its truth:-

(85:1) وَالسَّمَآءِ ذَاتِ الْبُرُوْجِ ۝

"By the sky that contains fortified spheres".

The earth is surrounded by fortified spheres which protect life on the earth, against the rebellious forces of Cosmic rays, Gamma rays, X-rays and Ultra-violet rays. These are named as Trophosphere, Stratosphere, Chemosphere and Ionosphere as stated earlier.

CHAPTER IV

Physical & Chemical Basis of the Universe

The distribution of tasks in the universe. (51:4) - مُقَسِّمٰتِ اَمْرًا

The planning and readjustment of the contents of the universe. (79:5) - مُدَبِّرٰتِ اَمْرًا

All objects in nature consist of chemicals. Even the living objects originated from chemicals. There are 92 different known *elements* which form the 'building bricks' of the universe. These 'bricks' can be transformed one into another. Mendeleev (1834-1907), a Russian scientist, discovered the Periodic law which is a statement of the fact that "properties of chemical elements are periodic functions of their atomic weights". That is, when they are arranged in order of their atomic numbers, elements having similar chemical and physical properties occur at regular intervals. Table of chemical substances illustrating the Periodic law is known as the Mendeleev Table (F·-

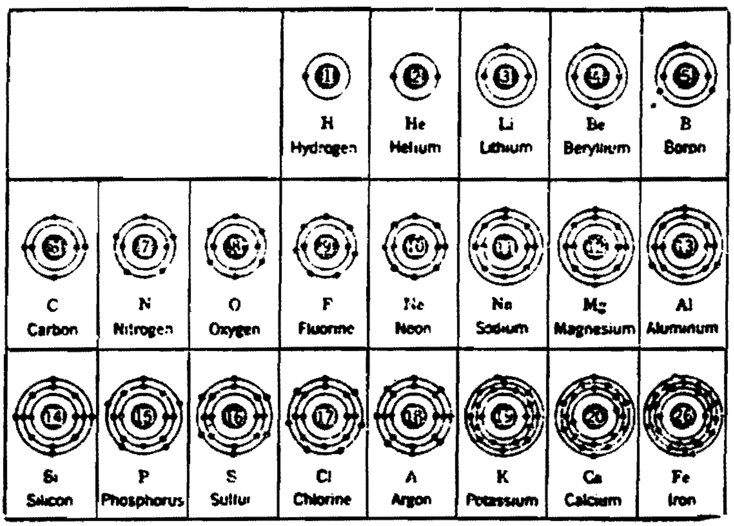


Fig.10--A PART OF THE MENDELEEV TABLE

The elements are arranged in this Table from No. 1 to No. 92, in order of their atomic weights. The elements in turn consist of tiny particles called *atoms*. An atom is the smallest complete unit of an element . For example, a carbon atom is the basic unit of the element carbon. Each element is given a chemical symbol. For example, the symbol of carbon is C and that of oxygen is O. Under certain degrees of temperature, pressure and concentration, all atoms except a few are liable to attach to and remain linked to certain other atoms. Such combinations of two or more atoms are called *compounds*. The binding forces which keep the atoms in a compound linked together are called *Chemical Bonds*. Each compound has a particular chemical name and a particular formula, which indicate what kinds and what numbers of atoms are present in that particular compound. For example, carbon dixoide is technically the compound of carbon and oxygen and is represented as CO_2 i.e., one atom of carbon is linked with two atoms of oxygen.

How are the chemical bonds between atoms produced? The atoms of all elements are constructed out of components collectively known as fundamental elementary particles which are of 3 types: *Protons*, *Neutrons* and *Electrons*. Protons and Neutrons are situated in the centre of an atom and are collectively known as Atomic Nucleus. Electrons revolve round the nucleus. (Fig. 11A). A Proton has a *Mass* (*Weight*) which is the same for all protons and is given the arbitrary unit Value 1. Neutron is the same as the Proton with no charge and thus its Mass is also 1. Mass of an Electron is 1/1800 and thus it is negligible. So the total mass of a whole atom is concentrated in its nucleus.

The mass of an atomic nucleus, i.e., the number of protons and neutrons present determine the *Atomic Weight*. For example, the simplest type of atom is that of Hydrogen. Its nucleus consists of a single proton and there is a single electron on the outside; neutron is absent. Since the nucleus of hydrogen has a mass of 1, its atomic weight is said to be 1. Next higher element is Helium. Its atomic weight is four and its nucleus contains 2 protons and 2 neutrons. Thus the atomic weights from element No. 1, i.e., Hydrogen to element No. 92, i.e., Uranium, go on rising step by step. Uranium is the heaviest of all elements. Its atomic weight is 238. Under certain conditions elements are interconvertible.

In addition to their mass, the elementary particles, of an atom also have certain electrical properties. Neutrons, as the name indicates, are electrically neutral. Protons are electrically positive, i.e., each proton carries one unit of positive electric charge. Electrons are electro-negative, each unit carrying one unit of negative charge. In each normal atom the number of protons is exactly equal to the number of Electrons. For example, the Oxygen atom has got eight protons positively charged and eight electrons negatively charged. Similarly in one atom of Sodium there are 11 positively charged protons and 11 negatively charged electrons. It means that the positive and negative charges in an atom are equal and thus an atom as a whole is electrically neutral.

Number of Electrons (or Protons) in an atom defines its Atomic Number. Thus hydrogen has *Atomic No.* 1, uranium has Atomic No. 92.

The electrons of an atom move around the nucleus at a speed of the order of 100,000 miles per second. An atom is thus like a miniature solar system. The nucleus is comparable to the central sun and electrons are comparable to the planets. Just as gravitational forces keep the planets in orbits around the sun, so also do forces of electric attraction keep the negatively charged electrons in atomic orbits around the

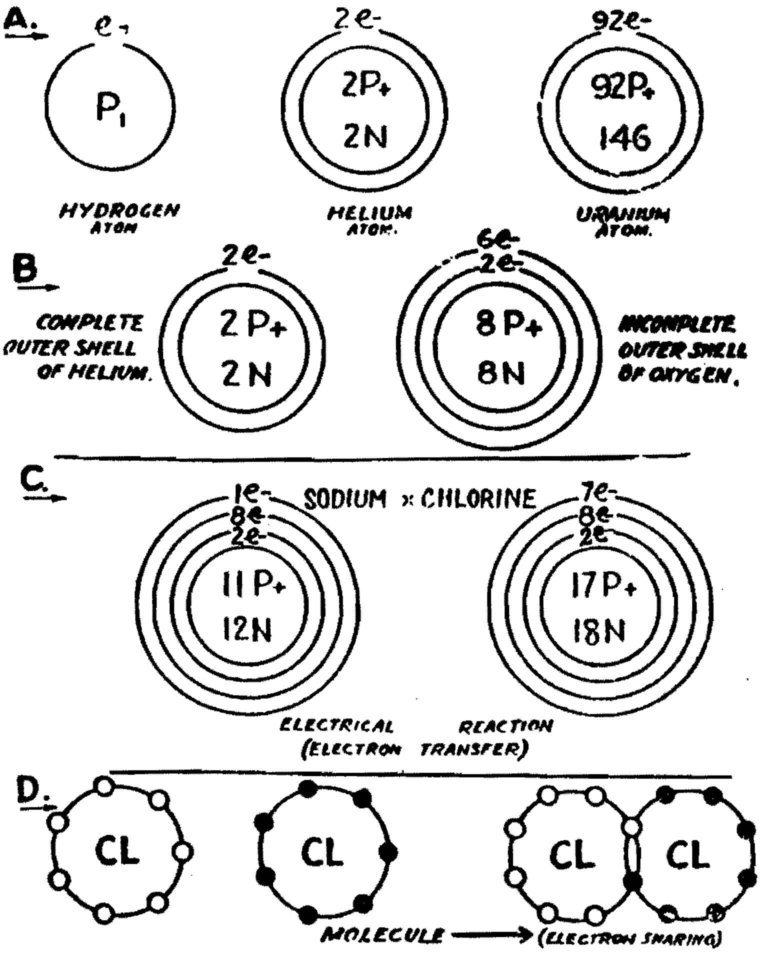


Fig. 11--ATOMS. Their structure and chemcial bonds.
(e-electron. P-proton. N-neutron.)

positively charged nucleus. Moreover, just as the planetary orbits are situated at specific distances from the sun, so also are the electrons' orbits located at specific distances from the atomic nucleus. The paths of the electrons at these distances may be said to mark out specific shells one outside the other known as *Quantum Shells.* Each shell can hold only a fixed maximum number of electrons. The first shell closest to the atomic nucleus can hold a maximum of 2 electrons; the second shell a maximum of 8 electrons. Known maximums also characterise all other shells. In the case of a Hydrogen atom the single electron normally orbits in the first shell. As this shell could hold two electrons, Hydrogen is said to have an 'incomplete' or 'open' shell. By contrast an atom of Helium possesses two electrons both orbiting in the first shell. In this instance the shell holds the maximum possible number of electrons and it is said to be 'complete' or 'closed'. (Fig. 11B). In an atom of Oxygen 8 orbital electrons are present. Two of these fill the first shell and the remaining six occupy the second. Since the second shell could hold 8 electrons, this shell of Oxygen is open. In atoms generally electrons fill the orbital shells from the innermost outwards. Thus depending on the particular number of electrons present in a given atom, the outermost shell is either complete or incomplete. An atom is electronically and chemically stable only when all of its electron quantum shells are complete. A Helium atom possessing just the two electrons necessary to complete the first shell, is electronically entirely stable. It is also quite inert chemically, that is, it is unable to react with other atoms. Similar is the case with elements like Neon, Argon, Krypton, Xenon and Radon called inactive or inert gases. In the atoms of all other elements the outermost shells are incomplete and such atoms are electronically unstable. If appropriate kind and appropriate number of such atoms come into mutual contact, their incomplete outer shells may make them undergo a chemical reaction. The result of such a reaction is the formation of chemical bonds between the atoms, i.e., a chemical compound is produced. Thus the chemical properties of atoms are determined by their outermost quantum shells.

Ions. Every atom has a tendency to complete its outer shell and so to become electronically stable and this is the underlying cause for chemical interactions among atoms.

Now let us see how an originally incomplete shell becomes complete. (Fig. 11C). Consider an atom of Chlorine. Of the 17 orbital electrons, 2 form the first complete shell, 8 a second complete shell and remaining seven an incomplete third shell. Thus a Chlorine atom can satisfy its strong tendency for completing its shells by gaining one more electron in its outer shell. Consider now an atom of Sodium. Of the 11 electrons present in this atom, 2 form a first complete shell, 8 a second complete shell and the remaining one lies in a highly incomplete third shell. If this atom were to lose its single electron in the third shell, practically its second shell would then become the outermost shell. Thus the atom would become complete and stable.

In other words Chlorine is unstable because it has one electron short and Sodium is unstable because it has one electron surplus, in their outermost shells respectively. In view of this both atoms could become stable simultaneously, if a single electron is transferred from one atom to the other. Actually this can happen under certain appropriate conditions, and such a reaction is called an *Eelctron-Transfer reaction*.

Such a reaction may take place between more than two atoms; and the electrons transferred may be more than one. In electron transfer among two or more atoms, those atoms which lose electrons are called *Electron Donors* and those which gain them are called *Electron Acceptors*. Now why should an atom, say for instance, of Sodium always be a donor and that of Chlorine and acceptor. This is because 7 negatively charged electrons of Chlorine and their oppositely charged nucleus are attracted towards each other with a much stronger force than the one between a single negatively charged electron of Sodium and its nucleus. Thus it is exceedingly difficult to dislodge as many as seven electrons in one batch. Hence Chlorine will always act as an acceptor. Thus with two suitable atoms close to each other, the one containing a lesser number of electrons in the outer shell will become an electron donor and the one containing a larger number will become an electron acceptor. We may note that electron donors are commonly known as Metals and electron acceptors as Non-Metals.

As electrons are negatively charged, their transfer from one atom to another results in important electrical changes. Let us again take for example the transfer reaction between Sodium and Chlorine atoms. An atom of Sodium is electrically neutral because it contains eleven positively charged protons and eleven negatively charged electrons. After one electron is transferred from Sodium to Chlorine atom, the Sodium atom becomes positively charged. Similarly the Chlorine atom which was neutral before transfer took place, became negatively charged after it received an additional electron from Sodium. Atoms or groups of atoms carrying electric charges are called *Ions*. Substances with opposite electrical charges are attached to each other through electrostatic force. Thus the oppositely charged ions are actually bound together to form Ionic-Compounds.

The number of bonds that an ion forms with others, indicates the valence of the ions. Thus Sodium is said to have a positive valence of 1. Similarly Carbon ion has a positive valence of 4. This applies only to the number of bonds actually formed. Whole atoms have valence of Zero. They have potential valences which become actual through gain or loss of electrons.

Molecules. An atom with an incomplete outer shell may satisfy its tendency to become stable in a different way. An acceptor may not have a suitable donor nearby for interaction but it may have other atoms of its own kind available. In such an event an atom, say of Chlorine, shall complete its outer shell by reacting with another Chlorine atom (Fig. 11D). When in close contact, each one of the two Chlorine atoms tries to pull strongly an additional electron from the other. But in this mutual pull neither of the two atoms is able to detach an electron from the other atom. This is so because the force of attraction between the nucleus and electrons of one atom is equal to the force of attraction between the nucleus and the electrons of the other atom. Thus a mutual pull continues, each atom holding its own electrons, as well as trying to pull an additional electron from the other. This results in the two atoms holding each other together and at the same time sharing one pair of electrons. In this way each atom completes its outer shell by keeping under its influence 7 electrons in its own outer shell and one electron in the outer shell of the other atom. Each atom behaves as if it actually possessed 8 electrons in its outer shell. More than one pair of atoms may take part in this sharing process. Atoms such as Carbon, Oxygen and Nitrogen always share electrons, as contrary to such atoms as Sodium and Magnesium which always transfer electrons. The compounds formed as the result of electron-sharing are called Molecules and the reactions producing them are called Molecular reactions.

Just after the origin of the earth, probably free atoms were present all over. Later on they formed compounds. With certain exceptions free atoms are not to be found now. They are in the form of ionic and molecular compounds.

ENERGY

The energy of a body is its capacity for doing Work. It is measured by the amount of Work which a body under a given condition can perform.

Forms of energy. Since mechanical energy, heat, light, sound and electricity are capable of doing work under suitable conditions, they are considered as different forms of energy.

Kinds of energy. The energy is of two kinds. (1) The Kinetic energy and (2) the Potential energy.

Kinetic energy. The kinetic energy of a body is the energy which it possesses on account of its motion. Examples: A moving railway engine, a bullet fired from a rifle, a stone falling from a height are examples of bodies, which possess kinetic energy.

Potential energy. The potential energy of a body is the energy which it possesses on account of its position or some special situation. It is equal to the amount of work, which the body can perform in coming from its given position or condition to some standard position or condition, called Zero position. Examples: Water stored in elevated reservoir, ice lying on the top of the mountain, brick lying on the roof of the house are examples of bodies that possess potential energy on account of their relatively high position. On the other hand, the funner of a watch, a compressed spring and a bow with its string stretched are examples of bodies that possess potential energy on account of some special condition.

Every compound has a varying degree of energy content, depending on the atoms of which it is composed of and on its pattern of structure. As already noted the atoms in a compound are bound together by mutual electrical pull. These binding forces which hold the atoms together represent Chemical energy or Bond energy. The greater the force of attraction between two atoms or ions, the greater is bond energy or capacity to do work. A chemical bond is not a permanent structure. It may be broken up by an external force pushing apart the component atoms or ions. The amount of work required to break such a chemical bond is also called Bond Energy. Once the two atoms or ions get disunited, they are free to unite again with each other or with some other suitable ions.

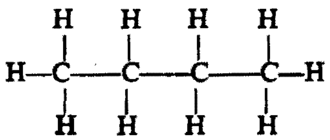
To start a certain chemical reaction, activating energy is required from an external source. How does this energy act? Take, for instance, heat which is the product of motion. As already described in Chapter III, all atoms, ions and molecules continuously vibrate at random, making back and forth movements. These movements are felt in the form of heat and measured as temperature. The greater the temperature the more violent the motions; they decrease with the fall of temperature until stop at 273°C. Thus the temperature of a certain substance is proportional to the amount of thermal agitation in its chemical units. With the application of heat from an external source, the thermal agitation increases, and the chemical units collide against each other with a greater frequency. The more they collide, the greater is the possibility of reaction taking place between them. But this happens only up to a certain limit. If the application of heat exceeds that limit, so that the atoms and ions in the compounds become so much agitated that the force of the heat motion becomes more than the force which binds them together, then the bonds that already exist begin to break. Any type of energy other than heat, such as ultraviolet rays, will produce the same two effects i.e., increasing the possibility of bond-making up to a certain limit and the breaking up of existing bonds beyond that limit.

Once a chemical reaction is started, energy is also required to maintain that reaction. The maintenance energy comes from two different sources, depending on the potential bond energy that different compounds possess--(1) From the environments, (2) From the reaction itself. As is more frequently the case, the starting compounds entering a reaction have a total bond energy less than the total bond energy of the resulting compounds. In such an event there is an energy deficit in the reactants which can only be made up from an external source. Such reactions which require energy from an external source are called *Endothermic*.

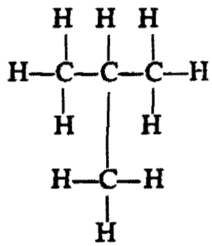
On the other hand if the total bond-energy of the starting compounds is greater than the total bond-energy of the resulting compounds, the reaction is self-sustaining i.e., the energy in the starting compounds not only maintains reaction but is also released to the environments. Such reactions are called *Exothermic*. The burning of petrol is an example. Once it is ignited, the reaction goes on automatically and releases energy which can be used for doing some other work e.g., running a motor. In this case the total potential bond energy of the petrol is greater than the total bond-energy of the end products, which are gases.

Types of reactions between compounds. The chemical properties of a compound depend on the following:-

(1) *Arrangement of the component atoms.* Two molecules may contain the same set of atoms, but if these are arranged differently the molecules will have different properties. For example--



and



This difference in the binding properties of otherwise similar molecules is particularly significant in the chemistry of living matter. As we shall see later, how physically and biologically different substances come into existence, simply by change in the arrangement pattern of atoms in a given molecule.

(2) *Number and type of the component atoms.* The number of atoms being the same, a molecule composed of atoms of high atomic weight will obviously be heavier than a molecule composed of atoms of low atomic weight. In the living world the molecules are mostly composed of oxygen, hydrogen, nitrogen and carbon, which are lighter elements. But the molecular weights of organic molecules are often exceedingly high. This is because an organic molecule is composed of hundreds and thousands of atoms. Here it is the large number and not the atomic weight which makes the organic molecule heavy.

As already noted, the compounds are not permanent structures. If subjected to the impact of appropriate amounts of external energy, they may undergo chemical reactions and become converted into different compounds. In the course of such a reaction, changes occur in the numbers, types or the arrangement of atoms of the participating compounds. Depending on the manner in which the structure of compounds become changed, four general categories of reactions may be distinguished:-

(1) Two or more compounds may add together and form a single larger compound. This is known as *Synthesis* reaction. For example,

NH_3	H_2O		NH_4OH
Ammonia +	Water	=	Ammonium Hydro-Oxide

(2) A given compound may break up into two or more smaller ones. This is known as *Decomposition* reaction, the reverse of *Synthesis*. For example,

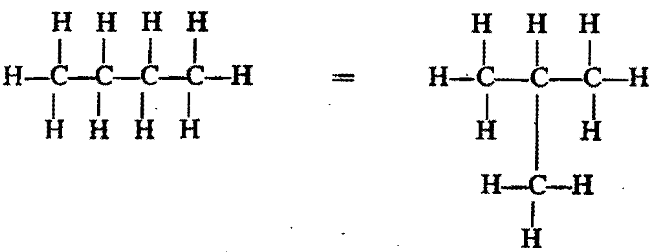
NH_4OH	NH_3		H_2O
(Ammonium Hydro-Oxide) =	(Ammonia)	+	(Water)

(3) One or more of the atoms or ions of one compound may change places with one or more of the atoms or ions of another compound. This is known as *Exchange* reaction. For example,

+ --	+ --	+ --	+ --
H Cl	Na OH	H OH	Na Cl

(Hydrochloric Acid) + (Sodium Hydroxide) = (Water) + (Sodium Chloride)

(4) Lastly, the numbers and types of atoms in a compound may remain the same but the bonding pattern of the atoms changes. This is called a *Rearrangement* reaction. For example,



Note that in all the four types of reactions the total numbers and types of atoms to the left of the equation are exactly equal to the totals on the right. In the reaction as a whole, atoms are neither gained nor lost.

Catalysis. Organic compounds are very complex. Reactions between them require very high activation energy. Thus, theoretically, living processes require very hot environments. But it is a common experience that organic matter is liable to be destroyed when exposed to excessive heat. Then how is it possible for such complex processes to be carried out at a low temperature in which the living matter normally exists. This happens by means of *Catalysis*. The reactions in living matter are enormously accelerated by catalysts which serve as a supplement to thermal agitation. Various types of catalysts are also present in the non-living world. Special catalysts in the living world which are proteins and are thus very highly complex compounds are known as *Enzymes*. An enzyme combines with the reacting compounds only temporarily and thus brings them close to each other. The reacting compounds which fit into the enzyme surface are called Substrates. Reaction between Substrates no more depends on chance collision but it becomes a certainty. Enzymes have definite molecular surfaces and the configuration of these surfaces differ, as the internal structure of the respective proteins of which they are made up of, differs. Thus the nature of surface serves as a key to enzyme reaction. This is evident from (Fig.12A.) The surfaces of molecules 'a' and 'b' fit into the surface of enzyme like lock and key. Reaction between 'a' and 'b' is thus no more a chance but a certainty. This indicates that every enzyme selects its own Substrates. Spatial configuration of different enzymes differs and this accounts for the phenomena of enzyme specificity. It means that a particular enzyme catalyses only a particular reaction. In (Fig.12B) Reactants 'a' and 'b' fit partially into the surface of the enzyme but Reactant 'c' does not. Hence the enzyme may speed up reactions involving 'a' and 'b', but not those involving 'c'. When the reaction between two subtrates is over, the enzyme molecule ultimately reappears unchanged, free to combine with a new set of substrates. The enzyme thus seves only as a medium and is not itself affected by such reaction.

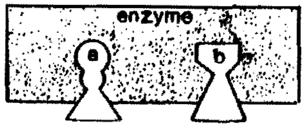


Fig. 12 (A). ENZYMES.
The surfaces of the molecules 'a' and 'b' fit into the enzyme surface. Now reaction between 'a' and 'b' no more depends on chance and is thus speeded up.

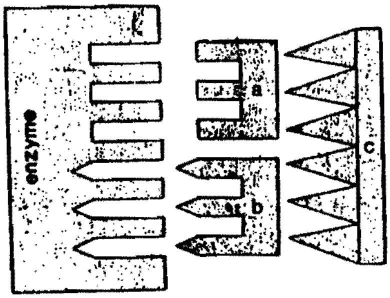


Fig. 12(B). ENZYMES.
Molecules 'a' and 'b' fit partially in to the surface of the enzyme; but not molecule 'c'. Thus the enzyme shall speed up reactions involving molecules 'a' and 'b' and not those involving 'c'.

Every chemical reaction has three basic *characteristics*. It takes place at a certain speed, it proceeds in a certain direction, and it has a certain duration.

Speed of Reaction. In addition to surrounding temperature and catalysts, the speed of reaction is also affected by the concentration of the reacting compounds present, the greaer is their number, the greater the speed. The reaction is thus proportional to the concentration of the participating molecules. This is known as the law of Mass Action.

Direction and Duration of Reaction. This concentration of molecules does not affect speed only, it also affects the direction and duration of reaction.

For example:--1 Glycerine + 3 Fatty-Acids = 1 Fat + 3 Water.

If the concentration of glycerine and fatty acid on the left of this equation is more than the concentration of fat and water on the right, the reaction will proceed to the right. On the other hand if the concentration is more on the right i.e., fat and water side, then the reaction will proceed to the left. The reaction shall continue, till a balance in concentration is achieved on either side.

The reaction is affected in two other ways. Firstly if we go on adding glycerine and fatty acid on the left, the reaction shall go on proceeding to the right. Secondly, if we go on removing the fat formed on the right side, the reaction shall again go on proceeding to the right. The latter shall happen rather more particulatly in those reactions where the products of reaction are either gas or a precipitate.

The forces responsible for the distribution of tasks in nature ملائکہ :

RADIATION

The term radiation is used in two senses. Firstly it is the process by which energy is propagated in space in the form of rays. Secondly the rays so propagated are also called Radiations.

Light Rays, Heat Rays, Gamma Rays are some examples of radiations.

Propagation of Radiant energy. Light and other such radiations are considered the result of rapidly alternating displacement current in the medium which gives rise to the magnetic effect. The two fields, namely the electric field and the magnetic, so produced, are inseparable, the one varying proportionately with the other. The variations of one field which give rise to the other, urge each other forward with a finite velocity, which is the velocity of light.

With regard to the origin of Electro-magnetic waves it may be stated that the atoms and molecules of matter contain electric charges, the vibrations of which send out electro-magnetic radiations. These radiations cover a very wide range of frequencies of wave lengths, depending on the quickness of alternation of the displacement currents. As a result we get the following chart of the different types of Electro-magnetic waves:-

Names	Frequency			Wave Length		
Cosmic Rays	10^{23}			10^{-11} CM		
Gamma Rays	6×10^{20}	to	10^{18}	10^{-10}	to	10^{-8} CM
X-Rays	6×10^{19}	to	6×10^{15}	10^{-9}	to	10^{-5} CM
Ultra-Violet Rays	2×10^{16}	to	8×10^{14}	1.4×10^{-6}	to	4×10^{-5} CM
Light Rays	4×10^{14}	to	4×10^{14}	4×10^{-5}	to	8×10^{-5} CM
Infra-Red Rays	4×10^{14}	to	3×10^{11}	8×10^{-5}	to	.04 CM
Wireless Rays	10^{13}	to	10^{3}	10 CM	to	100 K. meters

Form the above chart it is clear that although these Electromagnetic radiations go by different names, in different regions, they are essentially of the same nature.

The shortest waves are the Cosmic Rays whose origin and nature are not fully known yet.

The next short waves are Gamma Rays which are emitted by the spontaneous disintegration of radioactive atoms.

Next come the X-Rays which are produced by an atomic process when fast moving electrons strike material objects.

The Ultraviolet Rays arise when atoms or molecules are subjected to energetic excitation bombardment with fast moving electrons.

The visible region which affects the human eye (Light Rays) occupies a very small portion of the whole electromagnetic chart. The waves of this region are produced by the vibrations of electric charges within both atoms and molecules.

The longer Infrared Rays which are produced by molecular agitation can be detected by their heating effect.

Finally we get the Wireless Rays which are produced by oscillatory electric circuits.

All these different types of radiations are propagated with the same velocity through space and all of them consist of alternating electric and magnetic fields in mutually perpendicular directions.

RADIO-ACTIVITY

There are certain heavy metals like uranium, thorium and radium which give out some kinds of radiations for all time continuously and spontaneously and thereby they are converted into a series of elements of lower atomic number. These elements and their salts which too exhibit this property are known as Radioactive Substances and the phenomena of giving out radiations by them is called Radio-activity. Three types of radiations are given out by radio-active substances:-

1. Alpha Rays
2. Beta Rays
3. Gamma Rays

Alpha Rays. They comprise fast moving positively charged particles of mass, four times heavier than that of hydrogen nucleus. They are known to be nuclei of helium.

Beta Rays. They consist of a stream of electrons, moving with a very high velocity. As such they resemble the cathode rays in nature.

Gamma Rays. They are similar in nature to X-Rays and are, therefore, electro-magnetic waves in ether. Their wave-length is even shorter than X-Rays. They travel with the speed of light and have intense penetrating power. These rays carry neither mass nor charge. They are produced by the sudden stoppage of Beta-Rays, just as the X-Rays are produced by the sudden stoppage of Cathode Rays.

ATOMIC ENERGY OR NUCLEAR ENERGY

According to our common concept, matter and energy belong to two different categories and scientists too regarded them till recently as quite separate from each other. Matter in its own sphere was considered to be such that it could neither be created nor destroyed, by any physical or chemical means. This was the famous law of Conservation of Matter, upon which the whole science of chemistry was based. Energy in its own sphere was also considered to be such, that it could neither be created nor destroyed but only changed in form. In the year 1905, Einstein, the mastermind of modern physics, put forward the revolutionary idea that matter and energy are two aspects of the same stuff and that when matter is destroyed, energy is created in enormous quantity. He not only stated this fact but by his mathematical ingenuity discovered the famous equation E = MC2, which determines the relation between the matter destroyed and the energy created. (M--Mass of matter E--Energy in Ergs: and C--Velocity of light).

How large is the energy produced by the destruction of small mass of matter can be judged from the following example:-

If the consumption of electric energy in a house is 25 units per month, therein the energy produced by the destruction of 1gm. of mass shall be sufficient to supply electricity to this house for 1,000,000 months, i.e., for more then 80,000 years. The enormous energy thus created by the destruction of a small mass of matter in the nuclei of atoms of some suitable substance is known as Nuclear Energy or Atomic Energy.

Fission and Fusion. The actual destruction of a small mass of matter and the consequent release of nuclear energy is caused by one of the two processes, the fission and the fusion.

Fission. In fission the nucleus of any suitable atom is split up into two parts by the bombardment of a proton or a neutron. For example, when nucleus of uranium 235 is bombarded with a neutron*, it undergoes fission and is split up into two parts, one of which is the nucleus of barium and the other is the nucleus of krypton while 3 neutrons are given off. Counting the exact atomic weights of the elements, including fractions, the total final mass produced is less than the total initial mass. The mass thus destroyed in the reaction is converted into energy.

Nuclear Fusion. The second process of the release of nuclear energy is by fusion; in which two or more nuclei of suitable substances are fused together to form a new nucleus, thereby destroying a certain amount of matter and converting it into energy. For example when two deuterium nuclei (a heavy Hydrogen Nucleus-$_1H^2$) are fused together, they form an atom of helium nucleus $_2He^4$. In this case also the total final mass is found to be less than the total initial mass.

The solar radiations that supply energy for the maintenance of life on the earth, are produced by nuclear reactions inside the sun. The hydrogen is converted into helium. The actual processes are complex but the basic fact is that during fusion of the hydrogen atom and their conversion into helium, the total final mass produced is less than the total initial mass. The mass thus destroyed is converted into energy waves.

HUMAN ASPECT

We may thus summarize that electrons of all atoms in the universe move round their respective atomic nucleii at a tremendous speed. Moreover, all atoms, ions and molecules, regardless whether they are in a gas, liquid, or solid state, vibrate uninterruptedly at random, with back and forth movements except at a temperature below -273^{o}C. The ionic or molecular bonds are being made and unmade in every nook and corner of the universe. The energy is being released at one place and supplied at another. Energy in one form is being convered into another. One form of matter is being replaced by another. The matter is being converted into energy and vice versa. A pinchful of matter when disintegrated produces an enormous amount of energy. If this energy is released suddenly in the form of an atom bomb, it would produce a tremendous amount of destruction. But in nature the energy is not released for destructive purpose, the radiation waves do not diminish in one jot the substance of God's material creation but on the other hand they readjust the shape of the innumerable contents of the universe. Every particle of the universe has got a role to perform. Precious treasures are being shaped inside the oceans and in the depths of the Earth. The solar radiations reach the earth and promote photosynthesis in the vegetable kingdom. Food is thus prepared for the plants and animals. Innumerable other phenomena occur day and night. The making and breaking up processes continue uninterruptedly. All that is surplus is sorted out and all that is capable of survival is gradually raised up from one stage to another. Innumerable species of animals and plants become differentiated. The evolutionary processes are thus carried

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*Generally neutron is used for bombardment as it is not affected by the positive charge on the nucleus.

out constantly, in perfect silence and harmony and this all is due to the radiation waves. The Holy Quran describes the above phenomena in a graceful manner, so as to bring into light the process of Allah's Rububiyyat:

وَالْمُرْسَلٰتِ عُرْفًا ۝ فَالْعٰصِفٰتِ عَصْفًا ۝ وَّالنّٰشِرٰتِ نَشْرًا ۝ فَالْفٰرِقٰتِ
فَرْقًا ۝ فَالْمُلْقِيٰتِ ذِكْرًا ۝ عُذْرًا اَوْ نُذْرًا ۝ اِنَّمَا تُوْعَدُوْنَ لَوَاقِعٌ ۝

(77:1-7)

> "By the (waves of Radiation) that are sent forth constantly for the benefit (of humanity). Those that turn into powder (all that is incapable of survival): and still those that diffuse and make things differentiated one from the other; and make the law of (construction and destruction) unveiled before the humanity so that one may be able to justify his existence by a positive act or take warning from the destructive effect of a negative act. Assuredly that which you are promised must come to pass".

At yet another place the Holy Quran says:

وَالذّٰرِيٰتِ ذَرْوًا ۝ فَالْحٰمِلٰتِ وِقْرًا ۝ فَالْجٰرِيٰتِ يُسْرًا ۝ فَالْمُقَسِّمٰتِ
اَمْرًا ۝ اِنَّمَا تُوْعَدُوْنَ لَصَادِقٌ ۝

(51:1-5)

> "By (the radiation waves) that scatter (energy); by the (centrifugal and centripetal forces) that lift heavy weights; by the ease and gentleness with which (energy waves) flow; and by the distribution (of tasks) by command; verily that which you are promised is true".

We have already seen how the celestial bodies send out energy by nuclear fission or fusion and with what ease and gentleness this radiation flows. How the gravitational forces keep the huge big stars and planets with multimillion tons of mass in position? This pull of gravity is invisible and human knowledge is not yet fully developed to find out how it works. These forces of nature function in a state of perfect ease and gentleness. They distribute tasks at various levels not haphazardly but according to 'Specific laws'. It is not possible to enumerate the number and distribution of these tasks which are processed in perfect coordination and are evidence of the unity of Allah's plan.

MALAIKA

Two different roots of the word Malaika(ملائكة) as it occurs in the Holy Quran, are described in Arabic dictionaries. One is ' ا ل ک ' which means to send messages. The other is ' م ل ک ' which means power or energy.

All physical communication between any one point in the universe to another is carried out through the agency of radiation. On the other hand, all energy in the universe becomes manifest through radiation. The radiation waves, therefore, being the source of power and means of communication truly-come under the heading of the term Malaika, in so far as it relates to the physical universe.

Some of the functions of Malaika, as described in the Holy Quran are as follows:-

(1) The distribution of tasks all over the universe- مُقَسِّمٰتِ اَمْرًا (51:4)- as described above.

(2) The planning and readjustment of the shape of innumerable contents of the universe- (مُدَبِّرَاتِ اَمْـرًا).

As stated earlier, the making and breaking up of chemical bonds depends on the amount of activation and maintenance energy. With the increase in the amount of energy the bond-making processes increase up to a certain limit; beyond this limit the greater the energy the more the speed and violence with which the bonds break. The radiation waves smoothly sail across the space and being of different wave lengths, one type exceeds the other in potency, penetration and consequent effects on environments which are constantly changing. The whole universe is thus perpetually in a state of commotion. The Holy Quran describes this phenomenon in connection with a greater commotion that lies ahead:

وَالنّٰزِعٰتِ غَرْقًا ۙ وَّالنّٰشِطٰتِ نَشْطًا ۙ وَّالسّٰبِحٰتِ سَبْحًا ۙ فَالسّٰبِقٰتِ
سَبْقًا ۙ فَالْمُدَبِّرٰتِ اَمْرًا ۘ يَوْمَ تَرْجُفُ الرَّاجِفَةُ ۙ (79 : 1-6)

"By (the radiation waves) that undo (the bonds) with violence by penetrating (into Materials), and by those that undo (the bonds) with ease, and by those that smoothly float, one exceeding the other (in producing a particular type of effect) and thus readjust the shape of things (in the universe) by command of their Lord: that one day every thing that is in commotion, will be in violent commotion.

Means of communication other than radiation

The Holy Quran also describes means of communication other than the radiation waves:

اَللّٰهُ يَصْطَفِيْ مِنَ الْمَلٰٓئِكَةِ رُسُلًا وَّمِنَ النَّاسِ ۭ اِنَّ اللّٰهَ سَمِيْعٌۢ بَصِيْرٌ ۚ (22:75)

"Allah chooses His messengers from amongst the 'Malaika' and also from amongst the mankind. Lo! Allah has infinite vision and hearing".

According to the above verse the means of communication between the Creator and the creation are of two different kinds. Radiation is the link between the Creator and the physical word, including human body; and between the different constituents of the creation itself. The other link is the 'Divine energy'. This link is between the Creator and the living objects, and in the case of man it occurs through the chosen messengers of God from amongst the human beings. The nature and working of this link is beyond the perception of human beings other than the 'messengers' themselves. As regards the reception at the (so to say) "control post" of the Creator, it is perfect and infinite. (سميع بصير)

The other functions assigned to and performed by Malaika in the realm of امر are equally beyond human understanding.

CHAPTER V

Chemical Evolution

هُوَ الَّذِي خَلَقَكُم مِّن تُرَابٍ ۔ (40 : 67)

"It is He Who created you from inorganic matter".

Composition of the Stars and Planets. A star is a globe of incandescent gas. It may be assumed that a star condenses out of interstellar material which is mainly hydrogen. As it contracts and the internal temperature rises, nuclear reactions begin. As stated earlier, the hydrogen nuclei fuse to form helium nuclei with a slight loss of mass and release of energy. The supply of hydrogen being not inexhaustible, drastic changes take place eventually. There are two distinct types of stellar population. Population I, consists pre-dominantly of very hot bluish or white stars, as well as interstellar gas and dust. Population II, the brightest stars are red giants with little interstellar material. Red stars are later stage of evolution. Here the interstellar material has been used up in the formation of fresh stars. It is suggested that with the passage of time, the sun will become a red star of larger diameter and greater luminosity than at present so that earth will become too hot to support life. At a still later stage this may be followed up by a rapid collapse of the sun into a very small dense star, radiating feebly because of continued gravitational contraction, like the companion of Sirius (double star).

Solar System. As already noted in Chapter II, several hypotheses concerning the origin of solar system have been proposed, such as Nebular hypothesis of Laplace, the Planetesimal hypothesis, the Tidal Disruption theory of Jeans and Jeffreys. The view now widely accepted is that the solar system is the result of excessive rotation of a gaseous ball which was made up of free atoms. Hydrogen atoms were probably more abundant and the other heavier types were present in lesser quantities. The sun was formed when most of the atomic gas, hence most of the hydrogen, gravitated towards the centre of the ball. Even today the sun is composed mostly of hydrogen atoms. A swirling belt of gas remained outside. Eddies formed in this belt and in the course of time it broke up into a few smaller clouds. These spinning spheres of glowing gaseous clouds were probably the early planets.

THE STORY OF سلالة من طين

Chemical Evolution on the Earth (in relation to the Appearance of Life).

Thus to begin with, the Earth was probably a glowing mass of free hydrogen and other types of atoms, which eventually became sorted out according to weight. Heavy ones such as Iron and Nickel settled down in the centre of the Earth, where they are still present. Lighter atoms such as Silicon and Aluminium formed a middle layer. The very lightest, such as Hydrogen, Nitrogen, Oxygen and Carbon, collected in the outermost layer, (Fig. 13).

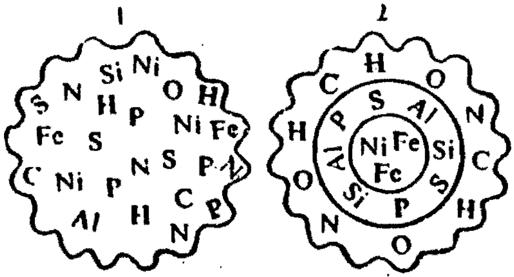


Fig. 13.—THE ELEMENTS COMPOSING THE EARTH

The elements became sorted out according to weight. Heaviest ones sank into the centre, relatively light ones formed the middle shell and extremely light ones formed the outer shell.

Temperatures must have been too high in the beginning for atoms to become linked together in the form of stable compounds, as the bonds would have been broken as fast as they might have formed. but under the influence of the cold of cosmic space, the earth began to cool down gradually. With the passage of time as the temperature of the earth became low enough, relatively stable compounds came into existence. Compounds thus formed multiplied and free atoms disappeared.

FIRST COMPOUNDS

As noted above, the outer layer of the gaseous ball that made the early earth, consisted mainly of Hydrogen, Oxygen, Nitrogen and Carbon atoms. As it cooled down enough to allow the formation of compounds, these four types of atoms played an outstanding role. As a result, even today 95% or so of the substance of all living matter consists of just these 4 elements.

On the basis of their known chemical properties, these elements presumably became linked into some half a dozen compounds as below:

WATER	H—O—H ,	H_2O
AMMONIA	$H-N\begin{smallmatrix} H \\ H \end{smallmatrix}$,	NH_3
METHANE	$\begin{matrix} & H & \\ & \vert & \\ H - & C & - H \\ & \vert & \\ & H & \end{matrix}$,	CH_4
CARBON DIOXIDE	O = C = O ,	CO_2
HYDROGEN CYANIDE	H — C ≡ N ,	HCN
HYDROGEN MOLECULES	H — H ,	H_2

The first three of these compounds came into existence not only on the Earth but on the other planets as well. For example, enormous amounts of water, methane and ammonia of undoubtedly abiogenic origin, are present today on the surface of the planet Jupiter in the form of thick permanently frozen solids. Methane and ammonia are also present on Saturn, Uranus and Neptune. Apparently these compounds must have been formed there as on Earth, but being too far away from the sun the surfaces of these planets probably froze before any further bonds could possibly occur. On the hot earth, however, the early compounds could interact further and give rise to new compounds later on.

Origin of First Mountain Ranges and Collection of First Compounds in Sea Water. As the hot gas ball of the Earth, gradually cooled down temperatures became low enough to allow some of the gases to liquefy and some of the liquids in turn to solidify. While passing from the liquid to the solid state, the very dense solids, like iron and nickel, sank into the liquid and as stated already, settled down in the center of the earth; while others floated like great icebergs, some sticking out of the liquid higher than the others, like cork and wood floating in the water because of the specific gravity being different in each case (Fig.14a). We know that the earth's crust is composed chiefly of two kinds of rocks, known as granite and basalt. The granite with a specific gravity of 2.7 and the basalt with a specific gravity of 3.0, both floated in the liquid earth mass whose specific gravity was 5.7. But granite stuck out further like cork in water while basalt floated like wood (Fig.14b). Consequently, when the entire surface had cooled down to a solid, it must have been irregular, with

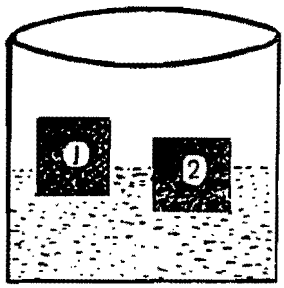


Fig. 14*a*.
Cork (1), floats at a higher level than wood (2).

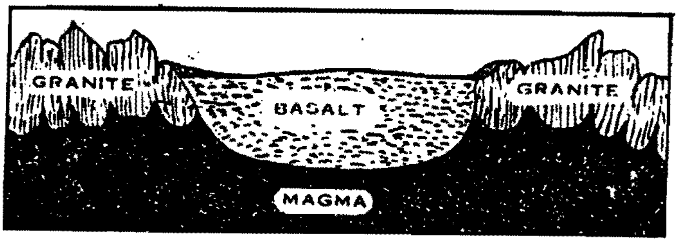


Fig.14*b*.--Masses of Granite and Basalt floating in liquid rock or Magma.

granite standing higher than the basalt. Thus the middle shell of lighter substances in the gas ball of the earth (Fig.13) gradually solidified to become the earth's crust, and the wrinkles and folds so formed gave rise to first mountain ranges. Surrounding this crust was the outer atmospheric covering which at temperatures then prevailing still remained gaseous. Up to this stage water was only present in the atmosphere in the form of clouds which surrounded the earth's crust, for probably hundreds of miles above its surface. As the temperature of the solid earth underneath was too high, water could not stay there in liquid form. As soon as it touched the surface of the earth , it evaporated immediately. But as the earth's crust became cool enough to allow liquid water to stay on, rains started. There was a continuous downpour for hundreds of years. Rivers flowed down from the heights of early mountains and water collected in the depressed areas to form the early seas (Fig. 14c). Atmospheric gases--methane, ammonia, carbon, dioxide and hydrogen cyanide-were washed down from

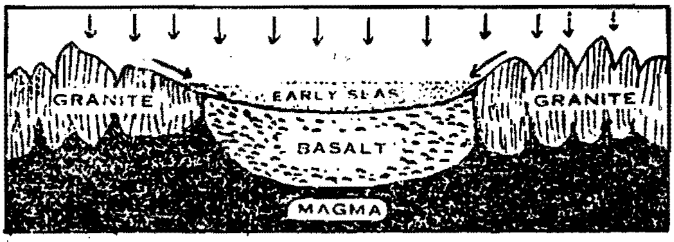


Fig. 14c.--Early seas formed over basalt basin.

the atmosphere into oceans. Salts and minerals also collected in the ocean water. These were obtained from three different sources, firstly from the land surfaces brought down by the rivers, secondly from the sea-shores, dissolved by the violent tides, thirdly from the interior of the earth brought by the molten lava bursting into the seas. This dissolving of gases and minerals into the ocean water was an important event with regard to the origin of life on the Earth.

ROLE OF FIRST COMPOUNDS IN THE ORIGIN OF LIFE

Role of Water. Life is not possible without water and water has always been the most important single component of living matter. It makes 60 to 90 per cent of the weight of living organisms, being more abundant in young cells or young organisms than the older ones, and in lower aquatic animals than in higher terrestrial types. Three-fourths of the earths surface today is covered with water and this is of great importance in the economy of living objects. It plays a fundamental role in life (*a*) in its being the best solvent for inorganic substances and for many organic compounds; (*b*) it favours the dissociation of electrolytes dissolved in it; (*c*) it has high surface tension; (*d*) it has got great fluidity; (*e*) it has a great capacity to absorb heat. It is thus an excellent medium for chemical reactions to take place. Moreover water was originally the only good source of hydrogen and oxygen. Both of these elements form the basis of building material of living bodies. But as noted already, free atoms of hydrogen and oxygen became unavailable soon after the origin of the earth. Water molecules then became the chief source of supply of these atoms. Even today water is the only usable source of hydrogen and one of the important sources of oxygen. *Water thus took the role of a key which opened the door to life.* The gases and minerals dissolved in the ocean water reacted with each other and with the water itself to form the early organic compounds and the subsequent chemical evolution led to the emergence of most complex organic compounds which became the precursors of the units of life. The point shall be amply illustrated in the following pages. After the life started on the earth, water still maintained its fundamental role in its control.

The Holy Quran says:-

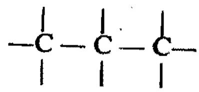
(21:30) ... وَجَعَلْنَا مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ ...

"And We made from water everything living".

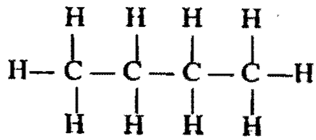
(11:7) ... وَكَانَ عَرْشُهُ عَلَى الْمَاءِ ...

"And He kept His control post (of life) on water".

Role of carbon. The chief actor on the stage of life set by water was Carbon which is a versatile element, with convalence of four, i.e., it can link with four atoms of same or of different kinds. Apart from this, carbon atoms may link up directly to other carbon atoms to form chains of varying lengths. Such as:



But these are not open chains, they form parts or fractions of whole molecules in which various other atoms or groups of atoms are attached to the carbon. For example if carbons of two or more methane molecules are joined into a chain, their hydrogen atoms will be bonded to carbon as follows:-



No other element approaches the self bonding capacity displayed by carbon.* The compounds like methane in the early oceans must have reacted with other compounds present there, giving rise to a large variety of carbon containing compounds. This happened to be a very important event in the evolutionary history of living matter, because carbon compounds provided the basis for the synthesis of numerous molecules which constituted the structural framework of living bodies. The carbon compounds are thus known as *Organic Compounds*.

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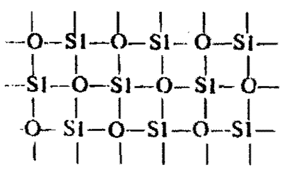
*Silicon can do this but only up to a limited degree. It can, however, give huge structures when bonded through oxygen atoms as:

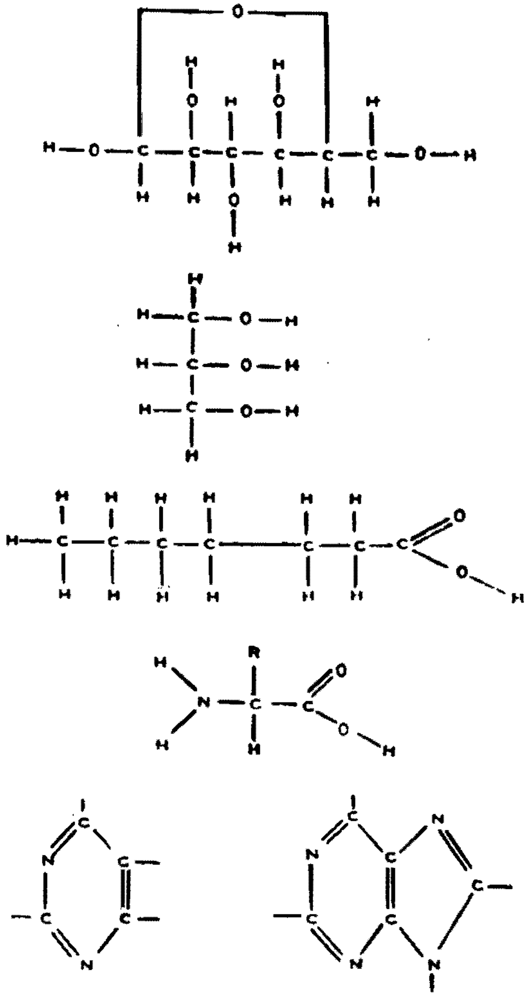


But silicon is not found intensively in living organisms.

COMPOUNDS OF CARBON

Among the numerous organic molecules which came into existence in the early seas, five categories became specially significant from the point of view of later developments.

These are (1) Sugars (2) Glycerines (3) Fatty acids (4) Amino acids and (5) Nitrogen bases. The structural make up of these compounds is shown in (Fig.15). Note that in each case a carbon skeleton, either a chain or a ring, forms the basis of the compound and that various group patterns of hydrogen, oxygen and nitrogen are linked to it.



1. Sugar. -- Sugars are short chains of carbon; 5 or 6 are common in organic matter. Other elements are H and O. Sugars with five carbons are Pentose, those with 6 carbons are Hexose.

2. Glycerines. -- Glycerines are chains of three carbon atoms. Other elements are same as in sugars, *i.e*,. H and O.

3. Fatty Acids. -- Fatty acids are chains of carbon atoms 2-20, other atoms are H and O. Carboxyl group COOH is at the end.

4. Amino Acids. -- They also contain COOH group. In addition contain NH2 (amino group). Both groups are attached to carbon; also attached is a carbon skeleton (R) which varies in structure considerably.

5. Nitrogen Bases. -- There are two major sub-groups, PURINES and PYRIMIDINES. Both contain ring structures of C and N; ring being single in pyrimidines and double in purines.

Fig.15. - COMPOUNDS OF CARBON

Sugars. Here carbon skeleton is a short chain which has five or six carbon atoms and they are particularly common in living matter. C_5 sugar is called Pentose, an important example is ribose ($C_5H_{10}O_5$). C_6 sugar is called Hexose, example is glucose ($C_6H_{12}O_6$). In sugars as in other carbohydrates the only elements attached to carbon are hydrogen and oxygen.

Glycerines. Also contain the same elements as sugar i.e., Carbon, Hydrogen, and Oxygen; but contain three carbon atoms in a chain.

Fatty acid. They also contain the same three elements as sugar and glycerine but carbon chain may vary from 2-20 or even more atoms. One end of a fatty acid molecule always terminates in COOH group called the carboxyl group which gives the molecule its acid properties.

Amino-Acids. Like other acids they also contain carboxyl group and in addition carry NH_2 or amino group. Both the carboxyl and amino groups are bonded to a carbon atom. To this atom is also attached a chain or ring of carbon skeleton.

Nitrogen bases. Nitrogen is also invariably present in Nitrogen bases which include two major groups *Pyrimidines* and the *Purines*. In both of them the molecular skeleton is always a ring containing carbon as well as nitrogen atoms, the ring being single in Pyrimidines and double in Purines.

Under conditions that prevailed in the primitive earth and on the basis of structural configurations it is presumed that the above five categories of organic compounds might have been formed as follows:-

Reactions							*End products*
CH_4 (Methane)	+	CH_4 (Methane)	+	H_2O (Water)		=	SUGARS GLYCERINES FATTY ACIDS
CH_4 (Methane)	+	H_2O (Water)	+	NH_3 (Ammonia)		=	AMINO ACIDS NITROGEN BASIS

Presence of cyanide could have provided useful material for Carbon and Nitrogen Rings.

Oparin in his book, 'The Origin of Life' proposed that earth in its early stages had a reducing atmosphere of Methane, Ammonia, Water and Hydrogen, and that organic compounds might be formed under these conditions. The hypothesis was accepted and followed successively by famous scientists like Urey and Bernal, and in 1953 was submitted to rigid experimental control by Stanley L. Miller in the Chemical Laboratory of the University of Chicago in U.S.A. Miller constructed a special apparatus in which for a longest period of time (one week) was produced an electric discharge in an atmosphere constituted precisely by aqueous vapours, methane, and ammonia. The water circulated continuously in changing states, from the liquid state in the boiling flask to the gaseous state in correspondence to the electrodes, and then again for condensation in the liquid state in the flask. It was observed from the first day that the water was light yellow in colour and then turned decidedly to dark red at the end of a week. It was evident that the colour depended on some organic compounds formed during the experiments. These compounds were submitted to a very precise chemcial analysis and were identified as Amino acids.

Source of activation energy and reaction energy for the above Reactions. Two different sources of enrgy were undoubtedly available on the primitive earth. One of these was the powerful electric discharge in lightning which must have occurred almost continuously in the early cloud-laden atmosphere. Secondly, although light rays could not pass through water vapours forming dense clouds around the earth for a long time , high energy radiations of the sun, such as Ultraviolet rays, X-rays and others could however pass through them. The energy from these two sources could have either acted directly on the gas molecules of the atmosphere and the resulting compounds could then have been washed down by rains into the seas. Or the reactions could have taken place in the waters of the oceans where methane and all other necessary ingredients were present in solution.

The early organic compounds described above, subsequently made possible the synthesis of macromolecules with unique chemical properties.

LATER ORGANIC COMPOUNDS

Presumably five major and several minor groups of new molecules emerged from the interactions of early organic compounds. Later, these came to have particular significance in the origin of life. The five major groups were:(1) Adenosine Phosphates (2) Polysaccharides (3) Fats (4)Proteins (5)and Nucleic acids.

Adenosine-Phosphates. These belong to a highly important class of compounds known as Nucleosides. A nucleoside molecule is a combination of a simple sugar and nitrogen base. For example:

Ribose (Pentose sugar) + Adenine (Pyrimidine) = Adenosine (Nucleoside)

Various kinds of sugars and Nitrogen bases in the early seas must have combined to form various nucleosides, including Adenosine. Plenty of phosphates could also be available in sea water which when combined with adenosine formed Nucleotides-

$$\text{Nucleotides}\left\{\begin{array}{l}\text{Adenosine} + 1\text{ Phosphate} = \text{Adenosine Monophosphate(AMP)}\\ \text{Adenosine} + 2\text{ Phosphates} = \text{Adenosine Diphosphate (ADP)}\\ \text{Adenosine} + 3\text{ Phosphates} = \text{Adenosine Triphosphate (ATP)}\end{array}\right.$$

Biologically occurring derivatives of phosphorus play a Key role in the energy transactions of living organisms. **ATP** is a 'high energy compound'. The expression 'high energy compound' or 'high energy bond', as used in biochemistry, has a meaning quite different from the physio-chemical significance of high energy bond. As noted early, in physical chemistry a 'high energy bond' is one which requires large amounts of thermochemical energy for dissociation. In biochemistry, on the other hand, the expression 'high energy bond' refers to the large free energy emissions associated with definite reactions of that bond such as hydrolysis or group transfer.

ATP (Adenosine triphosphate) has got one phosphate group more than ADP (Adenosine diphosphate). The addition of this third phosphate group to ADP requires a great deal of energy which may be provided by various energy yielding reactions, particularily decomposition reactions of organic material like sugars and fatty acids. The ATP so produced is a rich source of energy. If the bond between the second and third phosphate groups is broken, the energy released becomes available for the support of other chemical reactions. ATP thus serves as an intermediate product, it traps energy from one source and makes it available for a different reaction. This has got a great significance in the living matter today. For example the carbohydrates in the animal tissue cells, such as muscle cells, are utilised as a direct source of energy which is liberated when glycogen or glucose is broken down through a long series of phosphorylated intermediates and finally oxidised to carbon dioxide and water. Possibly, ATP has been the basic unit of energy transfer throughout the ages even before living matter existed. Solar energy continued to supply energy for reactions but Adenosine phosphates provided an alternative to it as a readily usable chemical energy source which could produce reactions independent of solar energy. This phenomenon had an important role in the origin of life because reactions involving the synthesis of complex organic compounds in living bodies cannot avail energy from physical sources directly. They require chemical energy and this is supplied mainly by ATP.

Polysaccharides. These are combinations of a few or many monosaccharide molecules. Polysaccharides may be composed of a single kind of monosaccharides (simple sugars), as in the case of Glycogen which contains several thousands glucose units; or Cellulose in which 2000 units are contained: or they may be composed of two or more kinds of monosaccharides.

The chemical process in which molecular units of similar or identical types are synthesized into a single larger molecule is known as Polymerisation.

Properties of Polysaccharides. (1) Building materials. (2) Energy source.

Fats. These are combinations of glycerine and fatty acids.

1 Glycerine molecule + 3 Fatty acid molecules = 1 FAT molecule.

Properties of Fats. (1) Building material. (2) Energy source.

There are many varieties of Fats depending on the types of fatty acids taking part in their synthesis. Living matter could not have come into existence with fats, polysaccharides and ATP alone in the early seas. Its origin became possible as the result of formation of protein and nucleic acid macromolecules.

Proteins. These are polymers of amino-acids. Some two dozen different types of amino-acids exist and any or all of these may be present in a protein in any number and any sequence. In many proteins as many as 100,000 or more amino-acids may be present. At the cellular and subcellular levels proteins provided building block units of far grater diversity as compared to polysaccharides, fats, water and other inorganic materials. Just as a chain of several hundred links can be looped and twisted into innumerable three dimensional shapes, so may a chain of protein be looped, coiled and twisted into a very large number of molecular shapes. It was due to proteins that a most complex and well finished structure as that of a living organism became possible.

The structure of proteins enabled them to function as enzymes and thus increased the speed of biological reactions tremendously. Reactions which could have taken centuries before the origin of proteins, could now occur within minutes and seconds. Proteins not only enhanced the speed of reactions but they also controlled the types of reactions that could occur in living matter.

Nucleic acids. In the early phase of the molecular evolution only simple molecules were formed. Later, more complex molecules such as amino-acids and proteins came into existence. In the more advanced phases of this period, it is believed that there appeared a molecule with two entirely new properties-(1) The ability systematically to direct the formation of copies of itself from an array of simpler building blocks. (2) And the property of acquiring new chemical configurations without loss of ability to reproduce. These properties, *self-duplication* and mutation, are characteristics of all living systems and they may therefore be said to provide an objective basis for defining the living state. This molecule was Nucleic acid.

Nucleic acids are high polymers of nucleotides. (Nitrogen Base + Simple Sugar + Phosphates) n = Nucleic Acid, where 'n' indicates large number. Nucleic acid molecules are as large or even larger than the most complex proteins. There are innumerable structural varieties of Nucleic acids. Any number and any sequence of nucleotides may be present in its molecule.

We may explain further the properties of nucleic acid described above:-(1) Nucleic acids are carriers of biological information in a structural code. The following shall illustrate-when a person speaks P-A-K-I-S-T-A-N, it gives us the information that he says Pakistan. But the above letters together make the word Pakistan only when they are spoken in the above sequence. Similarly the sequence of nucleotides in a given nucleic acid carries information or a set of instructions how to build proteins. The nucleotides sequence determines what kinds of amino-acids will make up a protein and in what order they will be linked together. Thus the specific configurations of differently structured proteins depend on the specific arrangement of the nucleotides in a nucleic acid molecule. (Fig. 16) shows information code and protein synthesis. If '1-2-3-4-5 represents a portion of a nucleic chain, the structural characteristics of the nucleotide segment 1-2 could be such that only amino acid 'a' could attach there. Similarly only amino acid 'b' might be able to attach to the nucleotide segment 2-3 and amino acid 'c' to the segment 3-4 etc. If then the amino acids become linked together and form a protein, the sequence of amino acids will have been determined by the coded information contained within the nucleic acid chain.

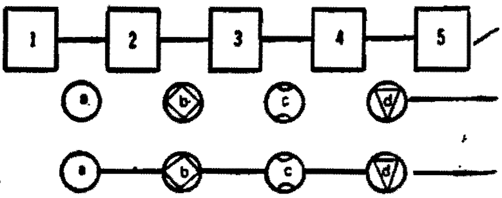


Fig.16--Nucleic acid provides information code for building protein molecules.

Thus in all living organisms today, proteins are synthesized according to building instructions contained in nucleic acids. This is of great importance because proteins provide the building blocks and also function as enzymes which control all reactions in living matter. In short all the life processes are ultimately controlled by Nucleic acids.

(2) *Auto-reproduction*--Depending on the above information carrying property is the unique property of Auto reproduction or duplication. The molecules of nucleic acids are able to synthesize new molecules perfectly identical to the model. The process is similar to the control of protein-synthesis by nucleic acid. In the building of proteins, the raw material was amino acids and here the raw material is nucleotides. Thus a nucleic acid molecule is able to reproduce itself without the aid of any other controlling agency. (Fig.17) indicates the process of nucleic acid reproduction. (A) A pre-existing nucleic acid molecule (*Shaded*) surrounded by raw materials (i.e., nucleotides) needed for the construction of a nucleic acid duplicate. (B) A nucleotide of a given type has affinity for a corresponding component of a nucleic acid. The respective nucleotides therefore get attached in matching sequence to the pre-existing nucleic acid. (C) The nucleotides having taken

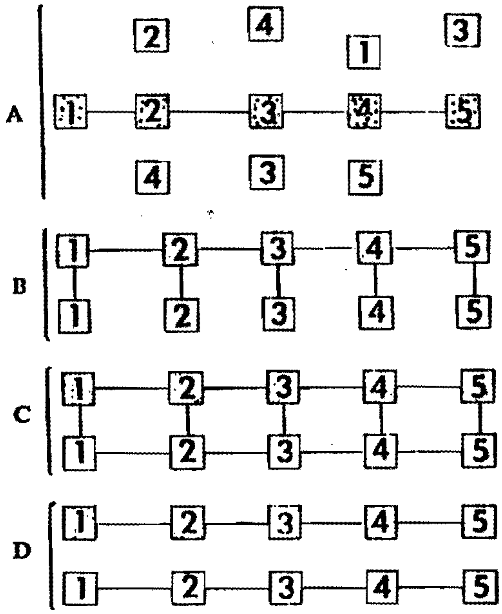


Fig. 17.—NUCLEIC ACID. REPRODUCTION.

up their positions link up with one. another. (D) The new nucleic acid molecule so created separates from the original model. Model and replicas are identical in composition.

The first nucleic acid probably came into existence through random polymerization of random nucleotides. But once the first nucleic acid appeared, it multiplied by the process of duplication. Thus reproductivity which is a peculiar characteristic of living beings, actually started at the molecular level, before the origin of first living units. The information code for the synthesis of particular proteins passed on from one generation of nucleic acid to the other, so that each generation could recreate the protein types of its ancestors.

(3) *Mutation*--Related to the property of Auto-reproduction is another unique property of nucleic acid which later became the characteristic of life. It is the property of acquiring new configuration without loss of ability to reproduce. Molecules of nucleic acids are most stable. They are not easily affected by the physical and chemical forces operating on the earth, as most compounds do. But occasionally certain chemical and physical agents such as ultraviolet rays succeed in producing minor changes in their structures. These changes may be (*a*) the alteration in structure of one of the component nucleotides, (Fig.18*a*); (*b*) Or a short sequence of

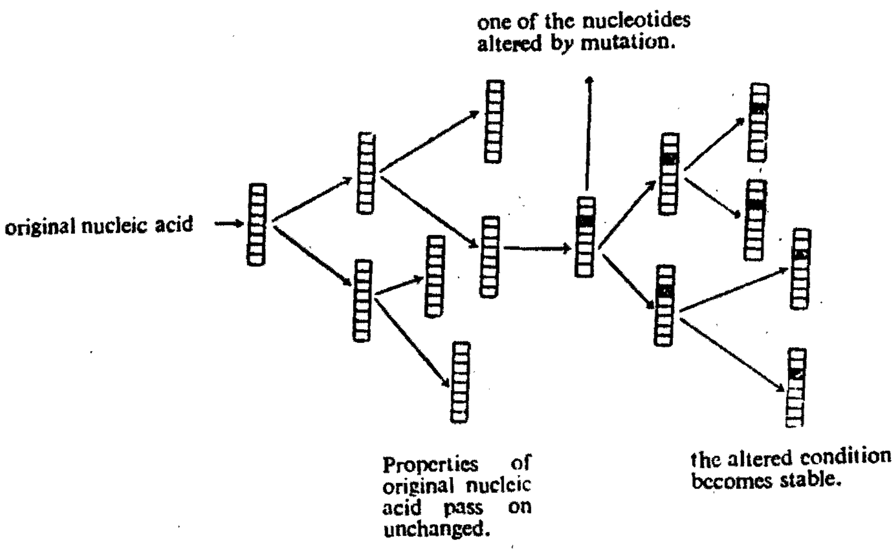


Fig.18a.--NUCLEIC ACID. MUTAION.

nucleotide chain may be detached from the rest of the chain at one particulate place and reunite at a different place; or in an inverted position; or the sequence may be correct, but during reproduction a wrong type of nucleotide gets attached at an otherwise correct position. (Fig. 18*b*).

Whereas metabolic errors or deviations in other compounds are constantly erased or repaired by the turnover process, the errors in nucleic acid synthesis become permanent. The altered nucleic acid becomes stable and later reproduces the changed condition which is transmitted from one generation to the other. Such stable alterations are called *Mutations*.

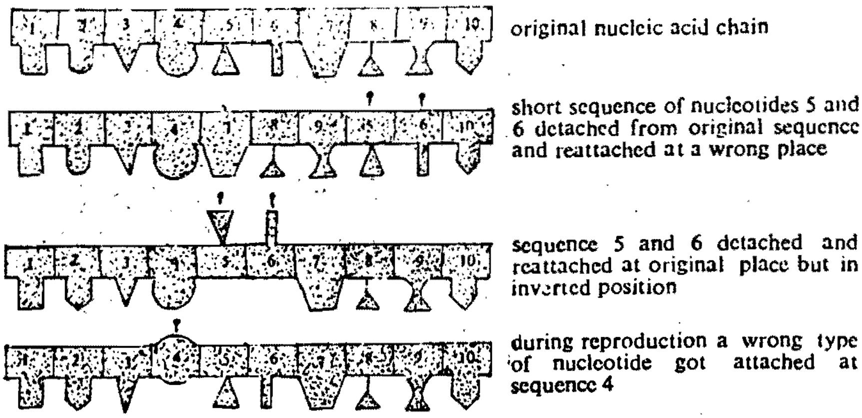


Fig. 18*b*.--OTHER ERRORS IN MUTATION.

Thus nucleic acids on the early earth not only reproduced their own kind but some of the descendent molecules became different from their ancestors. These differences accumulated through successive generations, so that entirely different and varied types came into existence.

As the nucleic acid molecules changed with the passage of time, the protein molecules whose synthesis depended on nucleic acid, changed accordingly, giving rise to new and diverse types of proteins. And proteins being the building blocks, diverse types of organisms came into being.

Thus the chemistry of the earth took entirely a new turn with the origin of nucleic acids. They carried genetic information from one generation of molecules to the other and controlled the protein synthesis accordingly. Moreover nucleic acid maintained its stability despite acquiring new chemical configurations. Some of the chemical processes on the earth thus ceased to occur at random and became strictly controlled both as regards their permanence as well as change.

A summary of Later Organic Compounds is given below in (Fig. 19)

1. Adenosine Phosphates.
2. Fats.
3. Polysaccharides.
4. Proteins.
5. Nucleic acids.

(1) Adenosine phosphates (Nucleotides).

Ribose (Pentose sugar) + Adenine (Purine) = Adenosine (Nucleosides).

Nucleotides:
- Adenosine + 1 Phosphate = Adenosine Monophosphate(AMP)
- Adenosine + 2 Phosphates = Adenosine Diphosphate(ADP)
- Adenosine + 3 Phosphates = Adenosine Triphosphate(ATP)

Properties-1. Energy Trappers and Energy Donors.

Source of Energy-Docomposition of sugars and fats.

(2) Fats-1 Glycerine molecule + 3 fatty acid molecules = 1 fat molecule.

Properties-(1) Building materials. (2) Energy source.

There are many varieties depending on types of fatty acids.

(3) Polysaccharides-Polymers of sugar molecules.

Energy source-ATP.

Example-Glycogen contains several thousand molecules of simple sugar.

Properties-(1) Building materials. (2) Energy source.

(4) Proteins-Polymers of amino acids.

100,000 or more amino acids may be present in a protein molecule. Some two dozen types of amino acids are known. Any number, any type and any sequence may be present in a protein molecule.

Properties-(1) Building materials. (2) Enzymes.

(5) Nucleic Acids-Polymers of nucleotides. Some molecules are as large or even larger than protein.

Properties-(1) Information code. (2) Reproduction. (3) Mutation.

Fig. 19.–LATER ORGANIC COMPOUNDS (SUMMARY)

The events described so far constitute molecular evolution. To describe briefly seven types of chemicals originated gradually in due course of time and accumulated in the early oceans:-

Inorganic Substances-(1) Water (2) Minerals.

Organic Substances-(1) Adenosine phosphates (2) Carbohydrates (3) Fats (4) Proteins and (5) Nucleic acids.

The subsequent events may be described as Prebiological stage of chemical evolution *i.e.*, the actual formation of first living units or cells from the above compounds.

PREBIOLOGICAL PHASE OF CHEMICAL EVOLUTION.

(Birth pangs of life on the earth)

Cells are the basic living units. They are microscopic watery drops which contain many types of organic and inorganic compounds. With the origin of cells the chemical evolution still continued, molecules still continued to produce new molecules, but out of the organic molecules emerged entirely a different creation, with the properties of life. This happened to be a most important landmark in the evolutionary history of the earth.

It is estimated that the first cells appeared 200 million years ago. The details of origin of first cells is not clear. The following is a general outline of the sequence of events which led to cell formation, consistent with the laws of physics and chemistry known today.

Origin of Cells. **The first cells may have been produced in the following ways:-**

Somehow or other the organic compounds described above assembled into small cohesive drops and by virtue of the properties of the aggregated material, life began to appear in these drops. The first question arises as to how could the aggregation of these organic compounds occur. The sea water in which they were present was too dilute a medium in which they could keep proper concentrations. Moreover it was difficult for all the necessary ingredients to assemble all at a time and stay in that condition for a sufficiently long period, because after chance contact the mighty waves of the sea were sufficient to disperse them again. Therefore it is much more likely that the assemblage of various molecules occurred at the sea shore, where they could stick to appropriate surfaces on solid ground.

ADSORPTION or PROPERTY OF STICKINESS is a surface phenomenon in physical chemistry and molecules of sugars, fats and proteins get adsorbed to various surfaces. Nucleic acid molecules are also very much adsorbable. On the other hand, fine particles of sand and clay are excellent adsorbing materials and plenty of them must have been present along the sea shore. Most probably some of the molecules got adsorbed into clay at random, at different places. More molecules of the same or different types might have been added later. Thus there was ample chance for all the key molecules to assemble inside the tiny little spaces in clay where they could form adequate concentrations to react with each other. The reactions could have been accelerated in the tidal zones, by evaporation of water.

It is not necessary that all the complex organic compounds such as polysaccharides, fats, proteins and nucleic acids were first formed in the ocean water and then aggregated into clay. Rather it is more likely that simple organic compounds such as sugars, fatty acids, amino-acids and nucleotides got adsorbed into clay where

the macromolecules of proteins and nucleic acids etc. got synthesized, because their sythesis required the close proximity of the necessary ingredients and the energy sources.

It has been experimentally demonstrated that if concentrated mixtures of amino acids are heated under NEAR DRY CONDITIONS, protein like compounds are formed. Similarly mixtures of other appropriate starting compounds heated under almost dry conditions can yield products having some of the characteristics of nucleic acids. The tiny pockets in clay therefore provided favourable environments for the concentration and mutual reactions between raw material molecules. Once the nucleic acids were formed, they must have been followed by protein synthesis and some of the proteins enzymes led to the formation of Polysaccharides and fats etc.

Mixtures containing fats and proteins have got the property of forming surface films. It is a common experience that if a cup of boiled milk or a plate of hot custard are allowed to cool, a thin film forms at the surface. Certain proteins have also got the property of forming precipitates out of solution which turn into granules or (threadlike structures). For example, during bleeding, fibrinogen in the blood plasma gets converted into fibrin (a threadlike structure) and a clot is formed. Polysaccharides, like cellulose (in plants), also can make films or fibrils. Thus some of the organic compounds in the tiny pockets in clay must have constructed external boundary membranes and internal network of fibrils in which the members of the assembly, i.e., water, minerals, ATP, Polysaccharides, fats, proteins and nucleic acids got enclosed. The individual units so formed came to be known as cells. Being protected by external membranes they could remain as separate individuals, even if they were washed into the sea later.

The first cells on earth must have come into existence in various parts of the world and their origin must have been preceded by numerous trials and errors. For a long time the right type of raw material molecules could not have aggregated together; or even after aggregation they may not have been in correct proportion; or if they fulfilled all the requirements for reactions to occur and proceed in the right direction, they could have been washed into the sea before the synthesis of end products could be completed. On the other hand the mixtures of raw materials, instead of remaining in the state of near dryness for an adequate period, could have dried up completely; or if all went well, up to the stage of cell formation, the cells themselves might have dried up and destroyed inside their places of birth by the heat of the sun. Yet after so many false starts and incomplete endings which continued for millions of years, some of the cells could leave the clay, to safely enter the sea water. With the conditions prevailing on the earth and the kind of materials that had accumulated in the early oceans, the origin of first cells was not a matter of chance but a matter of time.

It is not necessary that the above description corresponds in details to the actual events that took place in the remote past but such processes that could result in cell formation are plausible within the scientific domain of physics and chemistry.

The above description regarding the origin of life is based on the research work, by the world scientists during the last several decades. The evolutionary history beginning with unicellular organisms up to the appearance of Man shall be described later, but we must state at this juncture what the Holy Quran said fourteen hundred years ago, about this phase of chemical evolution passing on to biological and ultimately leading to the emergence of Man.

Let us point out at the outset that the Holy Quran is self explanatory and clarifies itself by presenting a subject in various ways and in different contexts, so as to make things easily understandable. Thus it is said:

وَلَقَدْ صَرَّفْنَا فِي هَٰذَا الْقُرْآنِ لِلنَّاسِ مِن كُلِّ مَثَلٍ ... (18:54)

"We have explained to mankind by displaying different aspects of things in this Quran, with every kind of similitude."

It has been explained already in this chapter, the phase of chemical evolution leading to the emergence of life cells which form the initial stage of Biological evolution and which ultimately led to the appearance of man on the stage of life: As we have noticed life originated from the inorganic materials of the earth. The Quran says:

هُوَ الَّذِي خَلَقَكُم مِّن تُرَابٍ ... (40:67)

"It is He who created you from dust (inorganic matter)".

The role of the first compounds in the origin of life, of which water has been the most important single component have been explained. Water as said earlier, took the role of key which opened the door to life. The Quran says:

وَهُوَ الَّذِي خَلَقَ مِنَ الْمَاءِ بَشَرًا ... (25:54)

"And it is He who has created man from water".

It means that the presence of two essential elements water and inorganic material of which the carbon was most important, took the basic role in the emergence of life. The Quran says:

هُوَ الَّذِي خَلَقَكُم مِّن طِينٍ ... (6:2)

"It is He who created you from clay". i.e. the combination of water and other inorganic materials.

A wrong notion is prevalent that the Creator first prepared the mould of man out of clay, gave it life and named him Adam. Then He bisected the side of his body and got out of it his زوج a female companion. From then onwards started the progeny of man. This is in fact a Biblical story which our commentators have monkeyishly copied, due to their ignorance of the scientific facts of chemical evolution followed by biological evolution, each one of which lasted for millions of years.

According to the Holy Quran, life came into existence not from a lumpsum of clay but from the extracts of clay which gradually reached the stage of man. The Quran says:

(23:12) ...وَلَقَدْ خَلَقْنَا الْإِنسَانَ مِن سُلَالَةٍ مِّن طِينٍ

"And We created man from the extracts of clay".

What is this extract of clay? It is the compounds of carbon which eventually evolved in to the later organic compounds such as Adenosine phosphates, polysacharides, fats, proteins and Nucleic Acids in the company of minerals.

As stated earlier, the organic material in the sea water stuck to the clay present on sea shores and formed a preliminary step in the creation of life. This combination however could not occur without the property of *adsorption* present in the molecules of organic compounds. The clay on the sea-shore was the excellent adsorbing material; the same property being also present in the fats and proteins etc. The Quran says:

(37:11) إِنَّا خَلَقْنَاهُم مِّن طِينٍ لَّازِبٍ ۝

"Verily We created them out of stickyclay".

As stated earlier, concentrated mixtures of Amino Acids when heated to near dryness, protein like compounds are formed. Similarily mixtures of other appropriate starting compounds, when heated under almost dry condition, can yield products having some of the characteristics of Nucleic Acids. This condition of near dryness could occur at such sea shores which were not affected by frequent tidal waves, for quite some time.

The Quran says:

(15:26) وَلَقَدْ خَلَقْنَا الْإِنسَانَ مِن صَلْصَالٍ مِّنْ حَمَإٍ مَّسْنُونٍ ۝

"And verily We created man from old physically altered mud which after a lapse of time reached the stage of near dryness".

---

*"Most of the commentators have wrongly interpreted the word حمأ in verse (15:26) above as 'putrified mud'. It is an established fact that decay was unknown on the earth before the orgin of bacteria which are living objects. The word حمأ actually means "old mud which with the passage of time had undergone physical and chemical changes; not putrifaction which is a biological phenomenon".

The same in repeated by saying:

(55:14) خَلَقَ الْإِنْسَانَ مِنْ صَلْصَالٍ كَالْفَخَّارِ ۙ

"He created man from mud nearly as dry as pottery (the stage of near dryness).

Thus in the verses described above the Quran provided significant pointers to the origin of life, in its own particular way: from earth (or inorganic matter); from water; from clay (or wet earth); from sticky adsorbent clay; not clay as a whole but from extracts of clay i.e., its active principles which were the precursors of the units of life; from old mud subjected to physical and chemical changes; from mud which reached the stage of near dryness.

The above was proclaimed in the 7th century A.D., by one who did not know how to read and write before revelation came to him. How beautifully the story of the creation of life was disclosed, at a time when human knowledge was extremely rudimentary. Even in the present age of advancement, how many people are there, other than the scientists, who know these facts?

CHAPTER VI

Life Appears on the Earth

كَيْفَ تَكْفُرُوْنَ بِاللّٰهِ وَكُنْتُمْ اَمْوَاتًا فَاَحْيَاكُمْ ... (2:28)

"How do you disbelieve in Allah (when you see that) you were without life and He gave you life".

BASIC PROPERTIES OF LIFE

The cells that exist today are composed of the same seven types of chemicals which constituted the first cells on the earth billions of years ago; i.e., water, minerals, Adenosine - phosphates, polysaccharides, fats, proteins and nucleic acids. The early cells drew inorganic as well as simple organic matter directly from sea water for their nourishment. This was a simple form of *Nutrition*. The raw materials thus used are called nutrients. The term food is used for complex organic nutrients.

As already noted, the decomposition reactions of organic materials such as fats and carbohydrates yielded energy which was captured by Adenosine-phosphates. These especially ATP served as a readily available source of energy for the chemical reactions within the cells. This process of trapping energy from one source, and transferring and packing it up in a different substance, we call *Respiration*. What is the significance of Respiration? The bonds between the Hydrogen, Oxygen and Carbon atoms of Carbohydrates and fats are low energy bonds, but for the complicated cellular reactions to take place very high energy source is required. This high energy source becomes available in ATP. Fuel molecules are smaller in number but high in energy contents. Thus ATP provides a readily available source of high energy within cells. We may call respiration a power generator which maintains life. Carbon dioxide is one of the products of respiration. As the respiring cells increased in number, the quantity of carbon dioxide consequently increased. Some of it dissolved in the sea water and the rest escaped into the atmosphere where it accumulated and formed a screen for high energy solar radiation, a portion of which could not reach the earth any longer.

With the availability of nutrients and ATP, a cell could duplicate nucleic acids. With increase in the number of nucleic acids more proteins could be manufactured. Proteins being enzymes could manufacture more fats and polysaccharides. Thus a cell could maintain itself by replacing the worn-out or damaged parts. This we call *Self repair*.

As the synthesized compounds got accumulated within cell, it became larger in size. Thus synthesis led to its *Growth*.

New types of compounds came into existence giving the cells new properties. This resulted in molecular *Development*.

As described before, nucleic acids became the ultimate controllers of cellular reactions. The cellular nucleic acids came to be known as Genes. Being gene-controlled cells became stable, so that the activities of cells such as nutrition, respiration, synthesis and growth could continue as before. That is why the cells still exist today and exhibit the same basic characteristics as the early cells.

The growth of a cell on account of synthesis and internal molecular reproduction could take place up to a certain limit, after which the cell became unstable. Thus the cell reproduced itself. By *reproduction* the cells not only became multiple but their generations continued in succession. Thus all cells that exist today are successors of the first cells on the earth. As the first cells increased in number, the nutrients in the sea water decreased. The cells had to compete for the supply of nutrients. Thus only those cells could continue their existence, which *Adapted* themselves to the new environments, i.e., either they could utilise the existing food more efficiently or more rapidly, or could find new methods of producing or procuring food.

Any change in the properties of cells could take place only if the genes had changed. This could occur by the occasional fusion of two cells. The fusion could be either partial or temporary, with resultant exchange of certain genes; or could be total and permanent, so that the genes of both cells became pooled together. With the change in genes the new cell properties became stable. This process of pooling or exchanging genes amongst two different cells came to be known as *Sex*. Genes could also change through *Mutation* which provided cells better chances of survival than sex. After mutation more cells and their offspring could get food in spite of competition.

The fusion of cells and gene change have always been at random. Any two cells may fuse by chance and any genes may get exchanged after fusion. This had two types of results. The new cells produced by pooling or exchange of genes had their competitive capacity increased or decreased according to the type of environments in which they were placed. The cells that adapted the new environments persisted in the succeeding generations. On the other hand, poorly adapted cells became extinct. Such changes, with the appearance of new types of cells with new characteristics, through successive generations, constituted *Evolution*.

Thus we may summarise that a living cell has got the following basic characteristics:-

(1) Nutrition (2) Respiration (3) Self repair or the maintenance of internal steady state (4) Synthesis resulting into growth and development (5) Reproduction and (6) Adaptation through sex and mutation. Collectively we may term these properties as life.

VIRUSES

Nucleic acid probably lay freely suspended inside the first cells in the form of clumps as we can notice in the primitive cells today. It must have happened that after accidental rupture or after death of cells these clumps escaped into the sea water where they remained inactive. But if they happened to enter another cell, they again became active and began duplicating themselves by using the living apparatus of that cell. These clumps of gene forming nucleic acid may have been the ancestors of viruses because this is how the viruses behave today. For example in the case of smallpox virus, it becomes active when it enters the cells of human body, and it begins to duplicate and produce specific types of protein. As the new types of protein are not tolerated by the human cells, reaction occurs in the form of disease.

EARLY CELL TYPES

Two types of cells are important from the point of view of early evolution. As noted above, first cells had nucleic acids freely suspended in their interior. The nucleic acids together with certain proteins formed nucleoproteins. In some of the descendants of early cells loose clumps of nucleoproteins concentrated towards the centre, but lay scattered inside the cells in direct contact with the endoplasm. This type of cell came to be known as *Monera*. Bacteria and Blue-green Algae are the modern representative of Monera group.

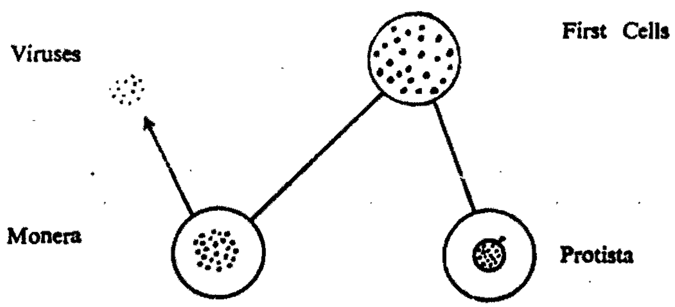


Fig.20.--EARLY ORGANISMS

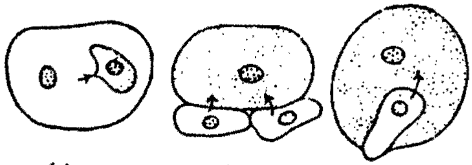
Bacteria are literally found everywhere, floating with dust particles in the air, in salt and fresh waters, in the water of hot springs, frozen in ice, in the upper layers of soil and in the bodies of plants and animals. They are often called germs or microbes because they live on or within the human body as parasites and bring about disturbances chiefly chemical which we term disease. Besides these parasitic forms which are few in number, human life and life in general on the earth, as we shall see in later chapters, could not continue long without the services of bacteria. Their size varies from 1/1000 inch to 1/50,000 inch.

In another major type that descended the first cells, the gene containing nucleoproteins concentrated in the centre of each cell, forming a loose mass. A thin membrane formed round the mass, and the nucleoproteins no more remained in direct contact with the rest of the cell substance. This type of cells came to be known as *Protista*. The loose central mass of cell later evolved into compact nucleus. All the modern plants and animals have descended from protista.

NUTRITIONAL EVOLUTION (ربُوبیّت)

There had been a tremendous expansion of living mass from the first cells on earth. It makes an interesting study from Quranic point of view how with the gradual disappearance of the free molecular food from the oceans, the nutrition of a vast number of organisms that branched out from the first cells, could be maintained. This happened in the following ways:-

(1) *Parasitism*. With the disappearance of free molecular food from the oceans certain organisms began to procure food from the bodies of living organisms. We noted above, how viruses entered living cells and became reactivated. Similarly a cell could invade another cell for obtaining food. This type of procuring food is called Parasitism. Even today viruses and bacteria get their food by Parasitism.



(*a*) (*b*) (*c*)

Fig. 21.—NUTRITION EARLY CELLS.

(*a*) Parasitism—Small cell consuming the substance of larger cell.

(*b*) Saprotrophism—Living on dead cells.

(*c*) Holotrophism—or eating. Larger cell engulfs the smaller cell.

(Arrow points towards the cell which eats the other).

(2) *Saprotrophism*. Here the organisms began to live on dead bodies of other organisms. Many types of bacteria adopted this method of obtaining food. Decay in the dead bodies of organisms results from the invasion of nutrients-gathering saprotrophic bacteria. The decay was unknown on the earth before saprotrophism, but these bacteria are so abundant today that anything exposed to air or water immediately begins to decay.

(3) Holotrophism. It is the process of eating whole living cell. In parasitism the smaller cell eats the substance of the larger cell, while in holotrophism the larger cell engulfs and eats the smaller cell.

It is evident from the above description that the above three methods of food gathering did not add anything to the total food stores on the earth. It was just one cell eating the other dead or alive. Thus unless some new food sources had become available, the life would have gradually ceased to exist on the earth. Such food sources did evolve and the cells themselves started manufacturing food within themselves. In early stages we noted that nutrients were produced by methane, ammonia and water, and energy was supplied by the sun and lightning in the clouds surrounding the earth. This method of food production became inadequate at a later stage, as with the disappearance of permanent clouds, lightning became rare; and with the formation of carbon dioxide screen in the earth's atmosphere, high energy solar radiation became unavailable. Thus the evolution of some new methods of manufacturing organic compounds became necessary. Water was still abundantly available and in addition to methane and hydrogen cyanide, carbon dioxide was available directly within cells as a source of carbon, this being the product of respiration. With water and carbon dioxide, cells could produce organic compounds, provided a source of energy were available. ATP could supply such an energy but this itself was an organic compound and its production depended on an external source of energy. Thus cells could continue to exist only if they evolved methods of utilising external sources of energy. This happened in two different ways:-

Chemosynthesis. Early Monera and Protista, especially certain types of bacteria, started extracting energy from sulphur, iron and nitrogen compounds. They absorbed these compounds into their bodies and on account of certain reactions that took place bonds were broken, and bond energy became available for the synthesis of carbohydrates from carbon dioxide and water. This process is called chemosynthesis and is still availed by certain bacteria. But the process had its limits, as it depended on the availability of certain chemicals.

Photosynthesis. Another method in which materials and energy could be available in abundance came into existence. A huge source of energy was present in the light rays of the sun, only an energy-trapping substance was required within the cell. Such substance came to be evolved in the form of Chlorophyll. The process of manufacturing organic compounds, by means of chlorophyll and light rays, came to be known as photosynthesis and is still used by the plant cells all over the world. It saved the living organisms from premature extinction.

We note that out of the five food procuring methods that came into existence sooner or later, i.e., Parasitism, Saprotrophism, Holotrophism, Chemosynthesis and Photosynthesis, only the last two added to the total food supply on the earth. It appears that Monera adapted all methods of getting food except eating. Protista adapted photosynthesis as well as holotrophism (eating). Two different types of organisms evolved from the protista. One group became specialised in photosynthesis and all the plants on earth evolved from this group. The other group specialised in holotrophism (eating) and became animals.

The above description of nutritional evolution illustrates a beautiful link in the chain of Allah's 'RABUBIYYAT' which is one of the attributes or basic characteristics of God and means the provision of sustenance to an object from its initial stage to the stage of final destination. The Holy Quran begins with the verse الحمد لله رب العلمين "Praise be to Allah, the Cherisher and Sustainer of the universe".

FREE OXYGEN MOLECULES REAPPEAR ON THE EARTH

As sated earlier, with the formation of first compounds, free molecules of oxygen, hydrogen, nitrogen and carbon disappeared from the earth. With the appearance of photo-synthesis free molecular oxygen reappeared and continued gathering in the atmosphere. The photosynthesis reaction is as follows:-

Carbon dioxide + water = Carbohydrates + oxygen.

This brought about a slow oxygen revolution on the earth. Oxygen has the property of reacting readily with other substances. Thus it reacted with methane to produce carbon dioxide and water:-

$$CH_4 + 2O_2 = CO_2 + 2H_2O$$

It reacted with ammonia to produce water and nitrogen molecules:-

$$4NH_3 + 3O_2 = 2N_2 + 6H_2O$$

It reacted with Hydrogen cyanide to produce carbon dioxide, water and nitrogen molecules:-

$$4HCN + 5O_2 = 2N_2 + 2H_2O + 4CO_2$$

Thus the ancient atmosphere containing methane, ammonia and hydrogen cyandie transformed into a modern one, containing water vapour, carbon dioxide, nitrogen molecules and oxygen molecules. At high altitudes, under the influence of high energy radiation from space, oxygen molecules reacted with one another to produce Ozone. As noted earlier, several miles above the surface of the earth, Ozone forms a screen against the high energy radiation and this is one of the guards (حفظتً) that protect life on the earth. Modern animals and plants are not adapted to high energy radiation and are killed by exposure to it. But the Monera and Protista which evolved before the formation of Ozone layer were adapted to high energy radiation and are still radiation resistant.

Free oxygen also reacted with the solid crust of the earth and converted pure metals and minerals into oxides which form the ores and rocks of the modern land. Moreover with free oxygen available in abundance a much more efficient form of respiration came into existence. The earliest cells had anaerobic (without air) form of respiration known as fermentation. It consisted of decomposition of food molecules without oxygen, which liberated energy that could be used in the formation of ATP. Free oxygen, on the other hand, could provide more energy, per food unit consumed, than in fermentation. Thus with free oxygen available, aerobic (with air) form of respiration came into existence.

Fig. 22.--EFFECTS OF REAPPEARANCE OF FREE OXYGEN MOLECULES ON THE EARTH.

EARLY REDUCING ATMOSPHERE CHANGED TO MODERN ONE	OXYGEN + METHANE → CARBON DIOXIDE + WATER OXYGEN + AMMONIA → NITROGEN + WATER OXYGEN + OXYGEN → OZONE
OTHER EFFECTS OF OXIDATION	OXYGEN + METALS → ORES OXYGEN + MINERALS → ROCKS OXYGEN + ORGANISMS → AEROBIC RESPIRATION

1. HYDROGEN ATOMS + HYDROGEN ATOMS → HYDROGEN MOLECULES
   HYDROGEN ATOMS + OXYGEN ATOMS → WATER
   HYDROGEN ATOMS + CARBON ATOMS → METHANE
   HYDROGEN ATOMS + NITROGEN ATOMS → AMMONIA
   CARBON ATOMS + OXYGEN ATOMS → CARBON DIOXIDE
   HYDROGEN ATOMS + CARBON ATOMS + NITROGEN ATOMS → HYDROGEN CYANIDE

2. METHANE + WATER → { SUGARS, FATTY ACIDS, GLYCERINES }
   METHANE + WATER + AMMONIA → AMINO ACIDS
   METHANE + WATER + HYDROGEN CYANIDE + AMMONIA → NITROGEN BASES { PURINES, PYRIMIDINES }

3. POLYMERISATION OF SIMPLE SUGARS → POLYSACCHARIDES
   FATTY ACIDS + GLYCERINE → FATS
   POLYMERISATION OF AMINO ACIDS → PROTEINS
   NITROGEN BASES + SUGARS + PHOSPHATES → { ADENOSINE PHOSPHATES OR NUCLEOTIDES }
   POLYMERISATION OF NUCLEOTIDES → NUCLEIC ACIDS

4. { WATER, MINERALS, CARBOHYDRATES, FATS, PROTEINS, NUCLEIC ACIDS, ADENOSINE PHOSPHATES } → FIRST CELLS → { VIRUSES, MONERA, PROTISTA }

   LIFE PROCESSES IN FIRST CELLS → { NUTRITION, RESPIRATION, SYNTHESIS, STEADY STATE CONTROL, REPRODUCTION, ADAPTATION }

5. NUTRITIONAL EVOLUTION → { PARASITISM, SAPROTROPHISM, HOLOTROPHISM, CHEMOTROPHISM, PHOTOSYNTHESIS → FREE OXYGEN REAPPEARS ON THE EARTH }

6. EFFECTS OF FREE OXYGEN MOLECULES ON THE ATMOSPHERE
   (1) EARLY REDUCING ATMOSPHERE OF METHANE, AMMONIA AND HYDROGEN CYANIDE CHANGED INTO MODERN ONE OF MOLECULAR OXYGEN, OZONE, MOLECULAR NITROGEN, CARBON DI-OXIDE AND WATER VAPOURS.
   (2) AEROBIC RESPIRATION STARTED IN ORGANISMS
   (3) METALS TURNED INTO ORES

Fig. 23.-SUMMARY OF EARTH'S EARLY EVOLUTIONARY HISTORY.
(In relation to the appearance of life)

CHAPTER VII

Cells--Chemical Organisation

وَمَا ذَرَأَ لَكُمْ فِي الْأَرْضِ مُخْتَلِفًا أَلْوَانُهُ ۗ إِنَّ فِي ذَٰلِكَ لَآيَةً لِقَوْمٍ يَذَّكَّرُونَ ﴿(16 : 13)﴾

"And the things of various colours that He has created for you in the earth, in them is a Sign for those who keep the working of the Divine laws before them".

As stated earlier, the first living bodies on earth were single cells. These gradually evolved into animals and plants that we see now. The world today thus consists of unicellular as well as multicellular organisms, the basic unit being a cell. Every cell differs from the other in certain respects. Moreover the chemical constituents of a cell are changing every moment. New materials enter a cell. Reactions within a cell change the incoming materials into new compounds, some of which are redistributed within the cell substance, others including the waste products leave the cell. These changes are continuous. But inspite of all the differences between cells and changes within cells, there are certain basic features which are common to all of them. Functions of a cell are based on the properties of its chemical constituents.

BASIC CHEMICAL CONSTITUENTS OF A CELL

95 per cent of the weight of a cell consists of four elements; oxygen 62 per cent, carbon 20 per cent, hydrogen 10 per cent and nitrogen 3 per cent. The rest 5 per cent of the weight of a cell consists of thirty other elements, including calcium, iron, sodium, potassium, magnesium, iodine, phosphorus, chlorine and sulphur as the main ingredients. In addition trace elements are present in particular types of cells. All the elements described above are present in the oceans. The cells having originated in the oceans, their contents and composition are a reflection of the oceanic water.

Minerals. All minerals present in a cell are present in the form of solution, except calcium salts which are present in the form of crystals around individual bone forming cells. Another element namely silicon is also present in crystal form in the outer cells of certain grasses.

Organic Components. As noted already, these are Carbohydrates (which include sugars and polysaccharides) fats, proteins, nitrogen-bases drivatives which include adenosine phosphates and nucleic acids. Like minerals, some of the organic substances form hard parts, for example wood, horn and chitin (the external covering of insects).

Carbohydrates. These, as we know, consist of carbon, hydrogen and oxygen. A carbohydrate with five carbons ($C_5H_{10}O_5$) is called pentose. Common example is ribose. That with six carbons ($C_6H_{12}O_6$) is called Hexose. Common examples are glucose, fructose and galactose. Sugars such as Pentose or Hexose are called monosaccharides as each represents a single sugar unit. Two monosaccharides joined together form a Disaccharide, a double sugar. Example is cane-sugar which is a combination of glucose and fructose. Two or more disaccharide molecules combine to make a polysaccharide. Examples are cellulose, glycogen etc.

Fats. As seen already, fats are formed by combination of one glycerine molecule and three fatty acid molecules. Like coal or petrol in an engine, fats serve as fuel in cells. They also form boundary membrances of cells where they contribute to controlling the movements of materials into and out of cells.*

Proteins. Are polymers of Amino acids. A protein may contain any type, any number and any sequence of amino-acids. Proteins may be categorised as Fibrous and Globular. Fibrous Proteins are relatively insoluble in water and provide the building materials for the structural framework of cells. Fats, carbohydrates and other materials get secondarily deposited in it.

Protein formation being under the control of nucleic acids, every organism has got specific types of proteins. Thus if protein from one organism is transferred to the body of another organism, it acts as a foreign body and produces disease. For example bacteria give rise to disease when they infect a host. Proteins of one animal when grafted into another, do not heal into place.

Nucleic acids. As we know, these are nucleotide polymers. Nucleotide is a phosphate of a nitrogen-base plus simple sugar pentose. Pentose may be either Ribose or Deoxyribose, the latter containing one oxygen atom less than ribose. On this basis we may distinguish between Ribose-nucleic-acids (RNA) and Deoxyribose-nucleic-acids (DNA). DNA forms genes and RNA functions as an intermediary between genes and the sites of protein synthesis in a cell.

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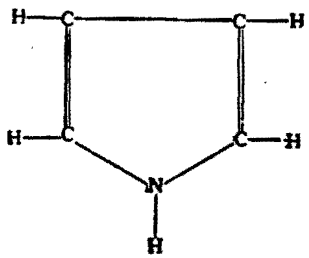
*Formerly fat was considered to be metabolically inactive substance. (For example, in human body it was supposed to be a reservior from which the body could draw calories during starvation or similar conditions. Its main day to day function was one of insulation against temperature changes and mechanical protection of underlying structures against minor trauma. We were also familiar with the aesthetic aspects of fat. But it was not considered as an organ in its own right. It is now known that fat plays a unique and central role in the economy of energy, a fact of which we were ignorant several years ago. To use an analogy, just as the capital of a bank cannot be allowed to be idle, so resources stored in the fatty tissue are not to be regarded as inactive or inert. To extend the analogy, although the amount of capital represented by fat may be constant, there is a continuous borrowing and lending of funds, with the result that, provided the weight remains constant, a zero balance is struck.

Other constituents of cell. In addition to fats, carbohydrates, proteins, nucleic acids and Adenosine-phosphates which form the bulk of living matter, a cell contains hundreds of other organic substances. These are present in minute quantities and yet they may be extremely important for the maintenance of life. One category of these substances is known as pigments. Besides their aesthetic aspect in the living world, pigments perform various extremely important roles.

Pigments. Three types are particularly significant--

(*a*) One group includes pigments known as *Tetrapyrrols*. A pyrrol contains a skeleton of five atoms of carbon and nitrogen arranged in a ring. Four such rings joined together form a tetrapyrrol. Tetrapyrrols of this type include red, blue, green and other varieties of pigments found, for example, in algae, in the shells of robin and other bird eggs and in mammalian faeces and urine.

(*a*) Pyrrol



4 such rings of pyrrol joined together form tetrapyrrol.

(*b*) Carotene ($C_{40}H_{56}$)

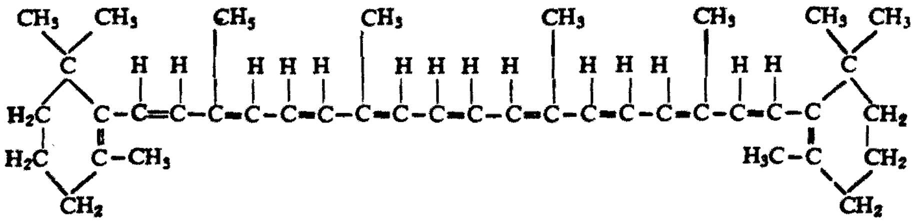


Fig.24.–PIGMENTS. (Chemical Structure)

In other tetrapyrrols, the four pyrrol rings are joined to form a larger ring in turn and in the centre of this larger ring is usually present a single atom of metal. A major pigment of this type is green chlorophyll, the central metal atom here being of magnesium. This is present in photosynthetic organisms. In another important type of ring-like tetrapyrrol, the central atom is iron and such pigments are red; for example, haemoglobin, the red oxygen-transporting substance in the blood of many animals (man and vertebrates generally).

(*b*) A second large group of pigments in organisms comprises *carotenoids*. They produce red, orange, yellow and brown colours. They are long chains of carbon atoms, with carbon rings attached at both ends of the chain. Two subgroups of carotenoids are the *Carotenes and the Xanthophylls*. Carotenes have a general formula C_{40} H_{56} and Vitamin A is its derivative. Named after the carrot in which carotenes are abundant, the pigments also occur widely in all leaves and are reponsible for the red, yellow or cream white colours of, for example, tomatoes, pumpkins, egg yolk, butter, milk and other plant and animal products.

Xanthophylls contain oxygen in addition to carbon and hydrogen. They are also widely distributed. A common Xanthophyll of leaves is lutien ($C_{40}H_{56}O_2$), which is responsible for the yellow colours in autumn foliage(مُصْفَرًّا).

(*c*) A third major group of pigments comprises the Anthocyanins formed among plants but not animals. An anthocyanin molecule is composed of several rings of atoms, the ring being joined in complex ways. They produce the deep reds and blues of plants as in many flowers, fruits and roots (e.g., beet-root). They are also manufactured in autumn foliage where they account for red colouration. They are water soluble whereas carotenoids and chlorophylls are fat soluble.

Most conspicuous in animals but not in plants is Melanin. It is responsible for yellow-brown, brown and black animal colours. Thus it occurs abundantly in hair, skin, in the inner layers of eyes and also in the interior membrances of some animals. Melanin is a chemical derivative of the amino acid tyrosine. Specialised pigment cells produce melanin, which accumulates in granules within such cells. If only a few melanin granules are present, the cell appears to be yellowish or brownish in colour. A black colour is produced by dense masses of granules.

The Holy Quran says:

وَمَا ذَرَأَ لَكُمْ فِي الْأَرْضِ مُخْتَلِفًا أَلْوَانُهُ ۗ إِنَّ فِي ذَٰلِكَ لَآيَةً لِّقَوْمٍ يَذَّكَّرُونَ ۝ (16:13)

"And the things of various colours that He has created for you in the earth, in them is a Sign for those who keep the working of the Divine Laws before them".

أَلَمْ تَرَ أَنَّ اللَّهَ أَنزَلَ مِنَ السَّمَاءِ مَاءً فَسَلَكَهُ يَنَابِيعَ فِي الْأَرْضِ ثُمَّ يُخْرِجُ بِهِ زَرْعًا
مُّخْتَلِفًا أَلْوَانُهُ ثُمَّ يَهِيجُ فَتَرَاهُ مُصْفَرًّا ثُمَّ يَجْعَلُهُ حُطَامًا ۚ إِنَّ فِي ذَٰلِكَ لَذِكْرَىٰ لِأُولِي الْأَلْبَابِ ۝ (39:21)

"Do you not see that Allah sends down rains from above and leads it through springs in the Earth? Then He causes to grow therewith produce of various colours. Then it withers and turns yellow. Then He makes it dry up and crumble away. Truly in this is a message to men of understanding".

These are the wonderful ways of the working of Divine laws in the physical world. We note how the same Carbon, Nitrogen, Hydrogen and Oxygen atoms in a molecule with change in their number and arrangement pattern, produce a variety of pigments. How the inclusion of a single atom of magnesium in a formula produces green colour, and the inclusion of an atom of iron produces red colour. How the addition of oxygen to carbon and hydrogen atoms ($C_{40}H_{56}O_2$) produces lutien, a yellow pigment of autumn foliage (مُصْفَرًّا) and so on.

Meaning of colour. It would be worthwhile in this connection to describe what we mean when we say that so an and so object has got so and so a colour. For example, we know that a plant is green because it contains a green pigment called chlorophyll. Why does chlorophyll look green?

For this let us recall the electromagnetic radiation, already described in Chapter IV. The constituents of electromagnetic spectrum which are of different wave-lengths extend from radio-waves to cosmic rays. The wave-length decreases from radio-waves, through infrared rays, light rays, ultraviolet rays, X-rays, gamma rays, to cosmic rays. Thus radio-waves are longest and least energetic and cosmic rays are shortest and most energetic. The light rays or the visible spectrum which is a part of the electro-magnetic spectrum described above is again composed of rays of different wavelengths. They range from violet, through indigo, blue, green, yellow, orange, to red in increasing lengths. Thus violet is shortest and most energetic, and red is longest and least energetic.

Shortest —
- Cosmic rays
- Gamma rays
- X-rays
- Ultraviolet rays
- Light rays ⟶ VIOLET — Shortest, INDIGO, BLUE, GREEN, YELLOW, ORANGE, RED — Longest
- Infrared rays

Longest — Wireless rays or Radio waves.

Colour is not an inherent property of an object. It is a sensation produced by stimulation of optic nerves by particular light vibrations and its interpretation by brain cells. When light from a self-luminous source falls on a particular object the light rays may be absorbed, or transmitted, or reflected by it. The transmitted or reflected rays when they fall into our eyes, are carried by optic nerves to optic lobe area of brain which interprets these vibrations as colour. (Fig. 25).

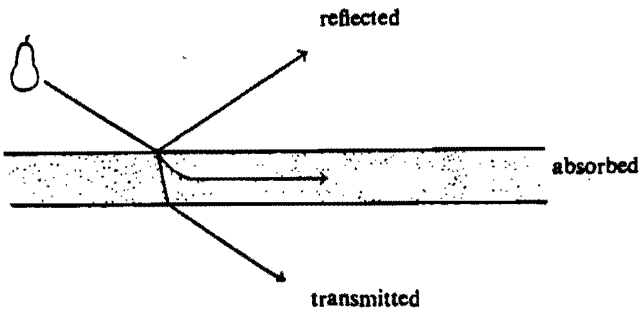


Fig.25.--LIGHT RAYS.
(Light rays reaching an object may be partly reflected, partly absorbed and partly transmitted.)

An object which absorbs all types of light rays (from violet to red) falling on it would be invisible. A black object approaches this theoretical condition very closely. An object which transmits all light rays, would be completely transparent and would thus be invisible. And an object which reflects all light would appear in the colour of light falling on it.

Thus the colour of an object depends on what type of light rays are absorbed, transmitted or reflected. Just as a radio-receiver is sensitive only to a portion of electromagnetic spectrum known as radio-waves, so the human eye is sensitive only to a portion known as visible spectrum or light rays. The optic lobe of the brain is so constructed that it interprets the shortest most energetic light waves as colour violet and the longest least energetic as colour red. Light waves of intermediate increasing wave-lengths are inerpreted as indigo, blue, green, yellow and orange respectively. Viewed together in a properly mixed beam such as sunlight the whole spectrum of visible waves is interpreted as white.

The subjective nature of colour is revealed in colour blind persons. These people can identify certain colours and not others. The defect here lies in the visual mechanism of the viewer and not in the object viewed.

We may conclude therefore that the light waves which chlorophyll reflects and transmits, and which make chlorophyll appear green to us, have intermediate length and energy content; and that the light waves which chlorophyll absorbs must be the other components of the visible spectrum, namely, the long red waves and the short blue-violet waves.

Similarly the colours of plants, animals, rocks, minerals and in fact of all the living and non-living objects around us varies with their respective chemical and physical structure and consequently upon the rays of solar spectrum that each of them reflects, transmits or absorbs. What a beautiful arrangement, for the display of beautiful colours in this beautiful world.

The scientists who explore nature and gain knowledge of natural phenomena are termed علماء 'Ulema' by the Holy Quran:

أَلَمْ تَرَ أَنَّ اللّٰهَ أَنْزَلَ مِنَ السَّمَآءِ مَآءً فَأَخْرَجْنَا بِهٖ ثَمَرٰتٍ مُّخْتَلِفًا أَلْوَانُهَا ۚ
وَمِنَ الْجِبَالِ جُدَدٌۢ بِيْضٌ وَّحُمْرٌ مُّخْتَلِفٌ أَلْوَانُهَا وَغَرَابِيْبُ سُوْدٌ ۝ وَ
مِنَ النَّاسِ وَالدَّوَآبِّ وَالْأَنْعَامِ مُخْتَلِفٌ أَلْوَانُهٗ كَذٰلِكَ ۗ إِنَّمَا يَخْشَى اللّٰهَ
(35:27-28) مِنْ عِبَادِهِ الْعُلَمٰٓؤُا ۗ إِنَّ اللّٰهَ عَزِيْزٌ غَفُوْرٌ ۝

> "Do you not see that Allah sends down rains from above? With it We then bring out produces of various colours. And in the mountains are newly created strata of rocks, white and red of various shades of colour, and intensely black. And so amongst men and crawling creatures and cattle are they of various colours. Those who posses the knowledge of these sciences (علماء) really appreciate the mighty powers of the laws of Allah. They know that His law is omnipotent and provides protection for those who abide by it".

The word جدد in the above verse is significant. Usually it is translated as "tracts". But actually it means the newly created strata of the Earth's crust.

جدد means 'new, or 'newly created'.

Let us recall that most sedimentary rocks were formed by erosion of other rocks. The action of air and water causes exposed rocks to crumble and the rainwater gradually moves the pieces downhill. After movement has ceased, some substance in solution in water deposits a cementing material which holds the pieces together to form a rock. If the pieces are large, we call it Conglomerate. Pieces about the size of sand grains form a sandstone. When the mass is like a fine smooth powder, the rock becomes a shale. The normal succession of sedimentary rocks is conglomerate, sandstone, shale and limestone. The limestone which is made principally of the shells of marine animals is formed only in clear water, and indicates the presence of very sluggish streams preceding the rock formation that could not carry even small particles. The sedimentary rocks may be turned into metamorphic rocks under the influence of heat, pressure, water and motion. Thus shale became slate, granite became gneiss, limestone became marble and sandstone became quartz. The changes involve recrystallisation and the formation of new minerals. Rocks are made up of minerals, and minerals themselves are composed of one or more of the natural elements. The compounds of different elements, e.g., carbon, copper, iron, aluminium, calcium etc., produce different colours. The colours of rock strata are further influenced by other factors. For example, limestone is white in colour, but when quite near the shores, mud may be mixed with it to give it a grey colour. Metamorphosis may change colours: for example, sedimentary coal is brown in colour, and when subjected to heat and pressure bituminous coals are formed which are dull-black in colour.

In the above-said verse (15:28), the display of various colours in the newly formed strata of the Earth's crust is referred to. Moreover this is the only verse in the Holy Quran where the word علماء is used, and here it is used for those who possess knowledge of natural phenomena.

OTHER CONSTITUENTS OF CELLS

In addition to the above constituents of cells there are other complex substances, such as derivatives of corbohydrates which form cells of animals and plants; and lipid derivatives, such as waxes which form covering films in plants; or cutin and sebrin which function as water-proofing and evaporation-resisting materials. Similarly, ralated to fats are the sterols, complex ring structures which form the molecular framework of a number of vitamins and of animal hormones which play major functional roles.

Weathering also affects the colouration of newly sedimentary rocks. Rocks exposed to weather for a long time assume a different colour. The chief agents responsible for weathering of rocks are (1) Air (2) water (3) Temperature changes and (4) plants and animals. The methods by which they cause changes are of two kinds; mechanical and chemical. It is only chemicals which cause change of colour. Air alone has no effect on rocks but air and water together are the chief agents of weathering. Oxygen and carbon dioxide are the gases of the air which with water cause important chemical changes in rocks of all kinds. Oxygen and water attack the iron found as a constituent of many dark coloured minerals, changing it to ferric oxide (rust). That accounts for the yellow, brown and red colours of most rocks and soils. The carbonaceous materias of plants also cause change in the colour of soils. The red colour is due to oxidised iron, produced by the chemical weathering of some rocks. There are two classes of iron compounds, ferric and ferrous. The ferric are red, yellow and brown in colour. Ferrous compounds are almost colourless. Hence a reduction of ferric to ferrous compounds by the carbonacous material of the humus, results in a change from red soils to colourless and finally black soils.

CHAPTER VIII

Biological Organisation

وَهُوَ الَّذِى فِى السَّمَآءِ إِلٰهٌ وَّفِى الْأَرْضِ إِلٰهٌ ۚ وَهُوَ الْحَكِيمُ الْعَلِيمُ ۝ (43:84)

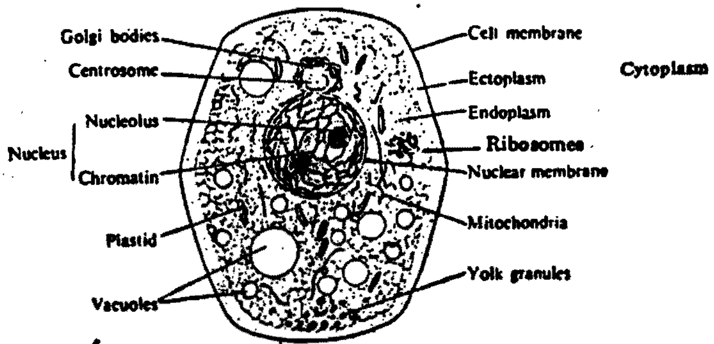
"It is He Whose authority prevails in the heavens and the earth (i.e., in the physical world, as well as in the human world). And He is full of wisdom and knowledge." The sociological laws given to mankind through the messengers of Allah are the reflections of the fundamental laws that govern the organisation of all matter at all levels. It indicates that the law-giving authority is One.

History and the Cell Theory. The cell theory was advanced by two German biologists, Schleiden and Schvann in 1838-1839. The theory states that all living organisms are composed of cells, a cell being the unit of structure and function; a multicellular animal or plant starts its life from a single cell (termed by the Holy Quran as نفس واحدة) which divides repeatedly to form a very large number of cells and ultimately develops into a new individual.

The discovery of cells started after the invention of microscope in the latter half of seventeenth century. Robert Hooke, an Englishman, discovered dead cells in a piece of cork. In 1831 Robert Brown, an English biologist, discovered the presence of nuclei within cells. In 1839 a Bohemian biologist Purkinje, termed the living substance out of which cells were made as protoplasm. Virchow in 1858 concluded that new living cells can arise only by reproduction of pre-existing cells.

The Basic Structure of Cell. Size of cell ranges in diameter from 2*m* (2 micromillimeters) to several millimeters but the vast majority are 5-15 *m*. In general the cells can be neither much smaller nor much larger than a certain standard. Too small a size would not provide enough room to accommodate the necessary cell apparatus and too large a size would increase the maintenance problem and at the same time reduce the efficiency of compact operation.

Most cells have two main subdivisions, the Nucleus and the living substance surrounding the nucleus, called the Cytoplasm (Fig.26). Cytoplasm and nucleus considered from the functional point of view, represent a physiological division of labour, within the confines of a cell. The nucleus is bounded by a nuclear-membrane, the cytoplasm by a cell-membrane. Surrounding the cell-membrane in many cases is a cell-wall, which is a non-living accessory.



NUCLEUS		Nuclear sap. Chromatin (Chromosomes)--Protein + DNA + RNA. Nucleolus--Protein + RNA.		
MITOCHONDRIA	...	RNA-Nucleoproteins + Respiratory Enzymes		
RIBOSOMES	...	RNA-Nucleoproteins + Enzymes (factories for protein synthesis).		
GOLGI BODIES	...	Produce cellular secretions.		
PLASTIDS (food factories)		LEUCOPLASTS	:	may store starch.
		CHROMOPLASTS	:	store pigments.
		CHLOROPLASTS	:	store green pigments.
CENTRIOLE	...	Functions in cell reproduction.		
VACUOLES	...	Transport raw materials from cell membrance to interior, and waste products from interior to outside.		

Fig. 26.--STRUCTURE OF CELL (*Animal Cell*).

Nucleus. A nucleus consists of three kinds of substances; a nuclear sap or nucleoplasm, in which are suspended the chromosomes and one or more nucleoli. The chromosomes are the principal nuclear structures. Chemically, chromosomes consist largely of protein and of nucleic acids, intimately associated into complexes called nucleoproteins. DNA is the principal nucleic acid of nucleoproteins but RNA is also present. Functionally chromosomes are carriers of genes which, as noted previously, are the ultimate controllers of cellular processes. Chromosomes are conspicuous only during cell reproduction. The exact number of chromosomes differs within the species. For example, a human cell contains 46 chromosomes, and this is its characteristic chromosome number.

A nucleolus is a spherical body which also consists largely of nucleoprotein but only RNA is present here. Nucleoli play an important part in the protein synthesis. The nuclear membrane which is constructed mainly of proteins and lipids, controls the traffic of materials between cytoplasm and nucleus.

If the nucleus by virtue of its genes is the control centre of cellular functions, then the cytoplasm is the executive centre. In it the directives of nucleus are carried out. But although the nucleus primarily controls, it also executes many directions of the cytoplasm.

Thus a vital reciprocal interdependence binds nucleus and cytoplasm, one cannot live without the other.

Cytoplasm. Consists of a semifluid ground substance in which are suspended various formed inclusions in the form of granules, rodlets, filaments or droplets. These are of various sizes and chemical compositions and may have a variety of functions. Particular cells have unique inclusions, not found elsewhere. The following are widespread among many or all types of cells:-

Mitochondria. These are short rods, 0.5 to 2 *m* (micromillimeter) in length. They have a predominantly fat-protein composition. In addition to RNA--nucleoprotein they contain respiratory enzymes i.e., enzymes required in energy producing reactions. These are chemical factories which carry out cellular respiration.

Ribosomes. These are minute granules and contain RNA--nucleoproteins and enzymes required in many synthesis reactions. They are known to be the chemical factories for protein synthesis.

Golgi bodies. They do not have the same appearance in all cases. They appear either as droplets or as piles of thin plates. They manufacture cellular secretion products and are conspicuous in actively secreting gland cells.

Plastids. These are round or oval disc like bodies found in the cells of plants and the photosynthetic organisms. These are of three kinds--(*a*) Leucoplasts--These are colourless and may function in the storage of starch in which case they are called Amyloplasts. (*b*) In the second kind of plastids, pigments are present; carotenes and xanthophylls are abundant but no chlorophyll. These are called Chromoplasts (*c*) The third variety of plastids contains corotenes, xanthophylls and chlorophyll in addition to it. Such green plastids are called Chloroplasts. These are the factories for food synthesis.

Centrioles. In the cells of some algae, some fungi and all animals, a single small granule is located just outside the cell nucleus. It functions in cell Reproduction.

Vacuoles. In addition to the above-said inclusions, cytoplasm contains fluid filled droplets bounded by membranes, called Vacuoles, and also some additional granules. They perform various functions. They may be vehicles transporting raw material from the cell surface to interior processing centers (*e.g.*, food vacuoles), or finished products in the opposite direction (*e.g.*, secretion granules); they may be places of storage (*e.g.*, starch granules, fat vacuoles, pigment granules) they may be vehicles transporting waste materials to points of elimination (*e.g.*, excretory vacuoles); or they may be special processing centres themselves.

The ground substance of the cytoplasm which under a light microscope appears to be a fluid but under the electron microscope, it turns out to be highly structured and organised. A network of exceedingly fine membranes can be shown to traverse the cytoplasm from plasma memberane to nuclear membrane.

ORGANISMS

All living things in nature exist in the form of individual organisms, some of which are Unicellular, others are Multicellular. In the multicellular ones cells are usually joined together into distinct *tissues*; tissues in turn are often combined into *organs*; and organs may be united into organ systems. As a multicellular organism matures, most of its cells specialise in various ways; i.e., they develop the capacity to carry out particular function; for example, muscle cells, nerve cells etc. The degree of specialisation varies. Specialisation in function is always accompanied by specialisation in structure. Thus maturing cells become diversified in appearance and extremely specialised cells become very much different from one another, as for example a nerve cell and an epithelial cell. Moreover such cells also come to differ greatly from the basic microscopic organisation of cells, as described in Fig. 26. The characteristics of very highly specialised cells are usually fixed and irreversible i.e., a cell specialised in one way cannot change and become respecialised in another way.

Tissues. They are formed by variously specialised cells. A tissue is an aggregation of cells in which each co-operates with all others in the performance of a particular group function. For example, in human body there are 4 types of tissues:-

1. Epithelial tissue. 2. Connective tissue. 3. Muscular tissue. 4. Nerve tissue. Epithelium covers or lines the body surfaces. Connective tissue has a passive function of binding together or supporting the functionally active structures like muscles and nerves (Fig.27).

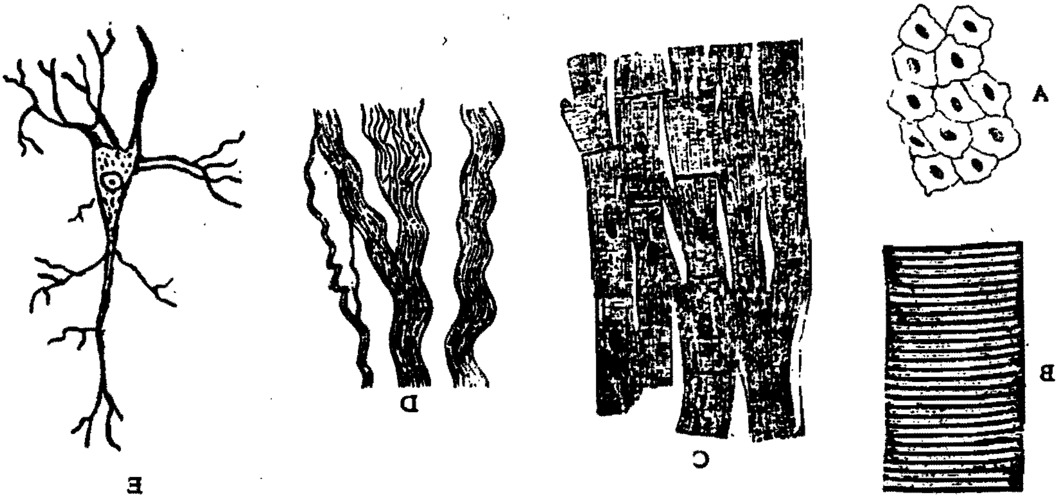


Fig. 27-- Animal Tissues.

A--Epithelial tissue.
B-Voluntary muscle-fibre (a number of muscle fibres together form the muscular issue).
C--Involuntary muscle-fibres.
D--Fibrous tissue.
E--Nerve cell. (a number of nerve cells together form the nerve tissue).

Organ and Organ System. An organ is an aggregation of tissues all of which cooperate in the performance of a group function. For example, heart (Fig.28a) is an organ which consists of Pericardium or outer covering formed of Fibrous tissue, Myocardium or muscular tissue which forms the organ and endocardium or the heart lining which is formed of epithetial tissue and elastic tissue (a connective tissue). Same is the case with an artery or a vein. Similarly, an organ system is a co-operating aggregation of organs. Several organ systems may be present in an organism. For example, Heart is one of the organs in our body and the Heart and Blood vessels together form the vascular system. Kidneys, ureters, urinary bladder and urethra together form a urinary system (Fig. 28b). Not all multicellular organisms necessarily possess organs and organ systems. The body of some of the primitive ones consists only of a single tissue. More advanced ones contain several tissues, some of these tissues often form an organ. Numerous organs and sets of organ systems, occur only in the most advanced organisms.

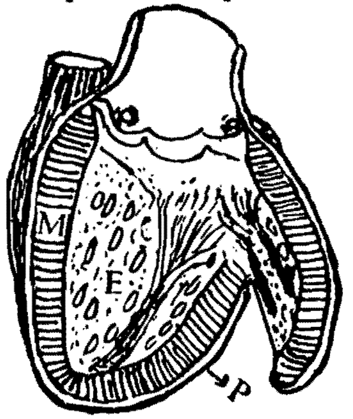


Fig. 28a.—HEART (an organ).
Section of the heart showing:—
P—Pericardium. M—Myocardium,
E—Endocardium.

NATURE OF ORGANISMS

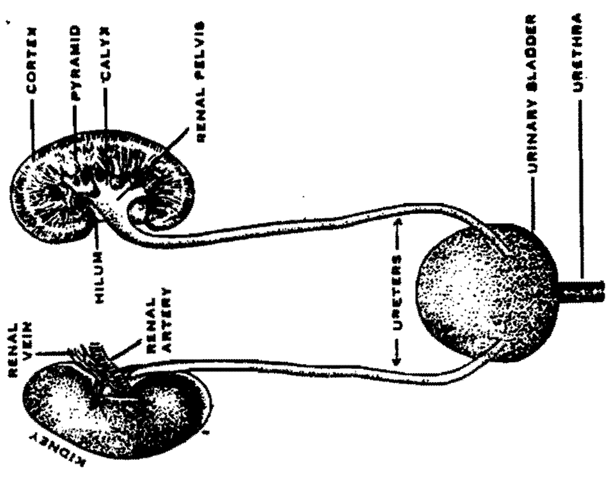


Fig. 28b.--ORGAN SYSTEM.
(Here kidneys ureters, urinary bladder and urethra together form an organ system.)

Now let us see what is basic and common to all organisms to qualify them as 'living things'? If a single cell can exist as a complete individual, why have the multicellular organisms come into existence? Moreover chemical composition alone does not show how a living organism differs from a dead one. What must organisms do to identify themselves as living creatures?

Cellular Activities. All organisms, whether unicellular or multicellular perform various activities which the very first cells had performed. These activities may be grouped into two broad functional categories, namely (1) *Metabolism* and (2) *Self-Perpetuation.*

Metabolism comprises the functions of nutrition, respiration and synthesis and all processes associated with these three. Nutrition provides the raw material for life. Respiration extracts energy from some of the raw materials. With a portion of this energy, synthesis transforms the other raw materials into structural components of living matter. The remainder of the energy and all the structural components then make self-perpetuation possible.

In practice, a machine if supplied the raw material, along with coal, petrol or electric energy, shall be able to produce parts necessary for its own repair. Metabolism therefore is not a distinguishing feature of living matter. That distinguishing feature is rather self-perpetuation which ensures that the machinery of an organism continues to run indefinitely, without outside help and despite internal changes which would otherwise stop its operation.

Depending on the energy and materials supplied by metabolism, self-perpetuation itself comprises three principal activities; Steady state control, reproduction and adaptation. With these three an organism can fight against the destructive forces arising from within and from without. This indeed makes an organism living and this is where it differs from a machine.

Steady State Control. An organism is a complex of control systems. These systems serve to receive information from the external environments and also from within the organism itself in the form of stimuli and respond to them in a self-preserving manner. For example, in human body when the food already consumed is exhausted, there is an automatic feeling of hunger. With the aid of inhaled oxygen and fresh food, nutrition is built up for the body cells. Our body adjusts respiration and synthesis in rate and amount according to the requirements of a particular moment. When food requirement for the cells of our body is great, for example during manual work, the rate of respiration and synthesis increases, causing replacement of parts that have undergone wear and tear. Another example -- If we tickle the foot of a sleeping individual, he at once pulls his leg up. The sensory stimulus in this case travel through sensory nerves, to sensory nerve centers in the spinal cord which in turn make contact with the motor cells in the same area, and motor impulses travel through the motor nerves to the leg muscles resulting in a response which manifests itself in the shape of pulling the leg up. Innumerable stimuli and responses work day and night for the self-preservation of a living body.

Reproduction. In spite of steady-state controls, the life of an organism has a limit, because the parts which maintain steady-state are themselves subject to wear and tear. The controls may break down gradually or suddenly by accident. If some controls cease to operate, the organism suffers from disease. Others still intact controls may then initiate self-repair. If so many controls break down, that self-repair is not possible by the remaining ones, then that organism must die. Again in this respect an organism resembles a machine. In spite of best service, a machine becomes inoperative ultimately. But here an organism exhibits a phenomenon which is beyond the scope of a machine. The organism may have reproduced. Reproduction in a sense anticipates and compensates for death, which is unavoidable. Through reproduction life continues through successive generations.

Adaptation. It is the final weapon for fighting against the destructive effects of environments. Effects of long-term environmental changes cannot be counteracted by steady state controls and reproduction alone. After a lapse of thousands or millions of years the climate may become entirely changed; mountain ranges, oceans and vast tracts of land may appear or disappear. Thus two related organisms, many reproductive generations apart may be placed in entirely different environments. The steady-state controls of an ancestor which successfully fought against the effects of early environments, if inherited unchanged by the descendant, would become entirely ineffective under the new environments. Therefore if the successive generations of an organism are to persist, they must undergo a change consistent with the change of environments. This change actually does occur through Adaptation which is the consequence of mutation, as well as of sex and heredity. Thus to define life we may say that any structure which metabolises and self-perpetuates is alive.

The Quranic word 'Barkat' (بركة) represents the following characteristics- Preservation, stability, growth and development, and manifestation. It rightly fits into the scientific word, self-perpetuation. Self-Perpetuation, as we have seen above, is the characteristic of living organisms. The Holy Quran used the word بركة in connection with the four eras of evolution of life on the earth as follows:--

وَجَعَلَ فِيهَا رَوَاسِيَ مِن فَوْقِهَا وَبَارَكَ فِيهَا وَقَدَّرَ فِيهَا
(41:10) أَقْوَاتَهَا فِي أَرْبَعَةِ أَيَّامٍ...

> "He made in it (the earth) the mountains, standing high above it; and bestowed ' بركة '(self-perpetuation) on it, and gave measures therein to provide nourishment to all things in due proportion, in four eras".

In the verse above, the words بارك and اقوات (plural of القوت -- means "nutrients") cover both self-perpetuation and metabolism.

LEVELS OF ORGANISATION

We noted in the previous chapters that subatomic particles, electrons, protons and neutrons together form an atom. The atoms of elements carbon, oxygen, hydrogen and nitrogen in the outer shell of the primitive earth aggregated together to form the first inorganic compounds. The aggregation of first inorganic compounds formed the early organic compounds and these in turn aggregated to produce later organic compounds. The organic compounds remained separate in the ocean water for millions of years. They could not reach a higher formation unless they aggregated inside the pockets in sticky clay on seashores, resulting in cell formation. The aggregative tendencies continued further. The cells united together to form multicellular organisms. Within the bodies of multicellular organism, tissues, organs and organ systems made their appearance. At a still higher level, as we notice, individual organisms of same kind come together to form families and populations. All organisms, families and populations of same type of organisms together form species. Different species live together in the form of communities. A sum total of all communities forms the living world.

Each higher level of organisation is structurally more complex than the one immediately below it, because it has got its own complexities, in addition to the complexities of all lower levels. Functionally each of these organisational levels have properties above and beyond those of lower ones. Moreover the members of each level are fewer in number than the one below it. For example, a muscle is one but its component cells are numerous. Thus from atom to living world we find a succession of organisational levels.

The creation and maintenance of each higher level of organisation requires energy. If energy supply is stopped to any organisation, it ceases to function and reverts to a lower level. For example, if a living organism dies on account of stoppage of energy supply, it will decompose and revert to inorganic matter. Similarly maintenance of a family or society requires work over and above that required to maintain the organisation of subordinate units. At each new level the expenditure of energy results in the appearance of new properties. One of these properties is *united integrated function*. Non-aggregated structure means independent function and consequently competition. Aggregated structure means joint function and consequently co-operative integrated unit.

Human Aspect. The law described above applies at every other organisation level, including human level. Men when independent compete with one another. When they surrender a part of their independence they form families and societies and start cooperating. Thus the laws that govern the human society are reflections of the fundamental laws governing the organisation of all matter from atoms to the whole living world. But human behaviour has been unique in this respect. Man lives in a society, a very complicated and organised society. Yet he wants to enjoy independence, out of all proportions to the social needs. This leads to non-co-operation and consequently conflict and disorder in the society. The Divine laws sent to humanity, through Allah's messengers, serve to remove this conflict. The basis of social order, that the Holy Quran directs to organise, is 'Adl' and 'Ihsan'. Adl means justice in all spheres of life; and justice means a condition where every individual in human society gets what is due to him, not only economically but all the fundamental rights that belong to him by virtue of being a man. This provides equal opportunities to individuals for the physical development as well as the development of their personalities.

On the other hand Ihsan means a condition where an individual (if inspite of his best efforts) lags behind, his deficiency is made good by others to restore the disturbed proportion in the society. This is done not by way of charity but according to the universal law that through 'United integrated function' the humanity shall be able to pass on smoothly to the next higher stage of its evolution.

As stated above, *the sociological laws given to mankind through the messengers of Allah are the reflections of the fundamental laws governing the organisation of all matter, at all levels. It indicates that the law-giving authority is One. It is only His law that can produce an integrated society and thus peace and harmony in the human world.*

Any other law-making authority whose laws are contrary to, or exceed the limits prescribed by the revealed fundamentals is described by the Holy Quran as "Other God". Moreover human beings in their primitive stage, raised false Gods from their imagination; as for instance, animals, trees, forces of nature and all sorts of things. The Holy Quran says:

أَمِ اتَّخَذُوا آلِهَةً مِّنَ الْأَرْضِ هُمْ يُنشِرُونَ ۝ لَوْ كَانَ فِيهِمَا آلِهَةٌ
إِلَّا اللَّهُ لَفَسَدَتَا ۚ فَسُبْحَانَ اللَّهِ رَبِّ الْعَرْشِ عَمَّا يَصِفُونَ ۝

(21:21-22)

> "Or have they chosen Gods from the earth; can they (false Gods) cause the living objects to arise from the non-living? If there were in the heavens and the earth other Gods besides Allah, there would have been disorder and confusion in both. But glory to Allah, the Sustainer with the supreme authority, (He is high), above what they attribute to Him".

As stated earlier, according to the Holy Quran a human being is composed of two things, physical body and human personality. Human body is controlled by physical laws as in other organisms and human personality is controlled by the revealed laws. The controlling authority for both the physical as well as the revealed laws is the same.

وَهُوَ اللّٰهُ فِي السَّمٰوٰتِ وَفِي الْاَرْضِ يَعْلَمُ سِرَّكُمْ وَجَهْرَكُمْ وَيَعْلَمُ مَا تَكْسِبُوْنَ ۝ (6:3)

"It is the law of Allah that operates in the heavens and the earth. He knows what is manifest and what is hidden in you (i.e., He knows your potentialities). And He knows what you earn by your deeds".

وَقَالَ اللّٰهُ لَا تَتَّخِذُوْٓا اِلٰهَيْنِ اثْنَيْنِ ۚ اِنَّمَا هُوَ اِلٰهٌ وَّاحِدٌ ۚ فَاِيَّايَ فَارْهَبُوْنِ ۝
وَلَهٗ مَا فِي السَّمٰوٰتِ وَالْاَرْضِ وَلَهُ الدِّيْنُ وَاصِبًا ۭ اَفَغَيْرَ اللّٰهِ تَتَّقُوْنَ ۝

(16:51-52)

"Allah has said: 'Choose not two Gods: For He is just one God: Then fear the consequences of going against My law'. To Him belongs what is in the heavens and the earth. It is His Constitution that works perpetually (i.e., valid for ever). Will you then abide by the law other than that of Allah?"

وَهُوَ الَّذِيْ فِي السَّمَآءِ اِلٰهٌ وَّفِي الْاَرْضِ اِلٰهٌ ۭ وَهُوَ الْحَكِيْمُ الْعَلِيْمُ ۝ (43:84)

"It is He Whose authority prevails in the heavens and in the earth (*i.e.*, in the physical world as well as the human world). And He is full of wisdom and knowledge".

There are so-called believers who believe in the laws of God that operate in the physical world but so far as the human affairs are concerned they do not consider the fundamentals contained in the revealed book of God as the Sovereign authority. The Holy Quran describes them as follows:

قُلْ لِّمَنِ الْاَرْضُ وَمَنْ فِيْهَآ اِنْ كُنْتُمْ تَعْلَمُوْنَ ۝ سَيَقُوْلُوْنَ لِلّٰهِ ۭ قُلْ اَفَلَا تَذَكَّرُوْنَ ۝
قُلْ مَنْ رَّبُّ السَّمٰوٰتِ السَّبْعِ وَرَبُّ الْعَرْشِ الْعَظِيْمِ ۝ سَيَقُوْلُوْنَ لِلّٰهِ ۭ قُلْ اَفَلَا
تَتَّقُوْنَ ۝ قُلْ مَنْ بِيَدِهٖ مَلَكُوْتُ كُلِّ شَيْءٍ وَّهُوَ يُجِيْرُ وَلَا يُجَارُ عَلَيْهِ اِنْ كُنْتُمْ تَعْلَمُوْنَ ۝
سَيَقُوْلُوْنَ لِلّٰهِ ۭ قُلْ فَاَنّٰى تُسْحَرُوْنَ ۝ بَلْ اَتَيْنٰهُمْ بِالْحَقِّ وَاِنَّهُمْ لَكٰذِبُوْنَ ۝

(23:84-90)

"Say: 'To whom belong the earth and all beings therein? (Say) if you have knowledge!' They will say: 'To God'. Say: 'Yet will you not receive admonition?' Say: 'Who is the sustainer of all the heavenly bodies, the sustainer with the supreme authority?' They will say: 'To Allah (they all belong).' Say: 'Are you not afraid (of standing against him)'. Say: 'Who it is in Whose hands is the governance of all things and who gives protection (to every thing) but there is no protection against Him? (Say) if you have knowledge'. They will say: 'the authority is that of Allah'. Say: 'then how are you deluded?' We have sent them the truth but they indeed practice falsehood".

The Holy Quran points out that some people accept the Sovereignty of God in the physical world, only because it does not affect their self-interests, but they deny it in the human world because it goes against their selfish motives.

وَلَئِن سَأَلْتَهُم مَّنْ خَلَقَ السَّمٰوٰتِ وَالْأَرْضَ وَسَخَّرَ الشَّمْسَ وَ
الْقَمَرَ لَيَقُولُنَّ اللّٰهُ فَأَنّٰى يُؤْفَكُونَ ۝ اَللّٰهُ يَبْسُطُ الرِّزْقَ لِمَن يَّشَآءُ
مِنْ عِبَادِهٖ وَيَقْدِرُ لَهٗ إِنَّ اللّٰهَ بِكُلِّ شَيْءٍ عَلِيمٌ ۝ وَلَئِن سَأَلْتَهُم
مَّن نَّزَّلَ مِنَ السَّمَآءِ مَآءً فَأَحْيَا بِهِ الْأَرْضَ مِنْ بَعْدِ مَوْتِهَا لَيَقُولُنَّ
اللّٰهُ قُلِ الْحَمْدُ لِلّٰهِ بَلْ أَكْثَرُهُمْ لَا يَعْقِلُونَ ۝

(29:61-63)

"If indeed you ask them: who has created the heavenly bodies and the earth, and subjected the sun and the moon (to His law)? they will certainly reply: 'Allah'. How are they then deluded away? (Why do they not base the human social laws on the revealed fundamentals?) Allah enlarges the sustenance to His servants or gives them by strict measures, according to His law. For Allah has full knowledge of all things. And if indeed you ask them: who it is that sends down rain from the sky and gives life therewith to the earth after death? They will certainly reply: 'Allah'. Say: 'Praise be to Allah'. But most of them are without wisdom".

The Holy Quran points out above that just as the sun and the moon and the falling of rain are controlled by God's law, so is the provision of sustenance to the human beings, controlled by it. But their selfish motives do not allow them to think over it.

It is pointed out further:

أَمَّنْ خَلَقَ السَّمٰوٰتِ وَالْأَرْضَ وَأَنزَلَ لَكُم مِّنَ السَّمَآءِ مَآءً فَأَنبَتْنَا
بِهٖ حَدَآئِقَ ذَاتَ بَهْجَةٍ مَّا كَانَ لَكُمْ أَن تُنبِتُوا شَجَرَهَا ءَإِلٰهٌ
مَّعَ اللّٰهِ بَلْ هُمْ قَوْمٌ يَعْدِلُونَ ۝

(27:60)

"Or who has created the heavens and the earth and whose law sends down rain from the sky, wherewith We cause to grow well planted orchards full of beauty and delight? It is not in your power to cause the growth of trees in them. Can there be another god besides God? Nay there are people who swerve from justice".

DIVISION OF LABOUR AND EFFICIENCY OF PERFORMANCE

We noted already that an aggregated structure means joint function and co-operation. Co-operation increases operational efficiency. Thus at any level, a higher organisation is functionally more efficient than the lower one. For example non-aggregated cells require more energy and materials for their individual survival than if the same number of cells were united to form a tissue. There are two reasons for it. Firstly because duplication of effort is avoided. For example, a single cell is exposed to environments all round and thus has to spend energy and materials to protect itself against the effects of environments on all sides. On the other hand, in the case of a compact aggregated tissue, only the cells at the periphery are in direct contact with the environments and they only take up the protective function. Secondly, in an aggregated tissue, no only that a duplication of effort is avoided, there is also a continuity of effort. For example, a unicellular organism has got to perform all the functions of respiration, digestion, excretion, locomotion and reproduction. Thus it can perform only one function at a particular moment, the other being temporarily suspended in the meantime. As reproduction is also the function of the same cell, therefore it suspends both feeding and lomotion. In multicellular organisms on the other hand there is a division of labour. Every individual function is the responsibility of a particular group of cells. For example movement is the function of muscles, digestion is the function of alimentary tract, secretion is the function of glands and so on. Thus each group of cells is specialised in a particular way.

Specialisation is also beneficial in certain other ways. Expenditure of energy is less and efficiency of performance is more in specialised cells. As a unicellular organism has many functions to perform, it is not as sensitive to environments as the highly specialised sensory cells in higher forms of life. A multicellular organism is thus able to react against the effects of environments much rapidly and efficiently. This explains the significance of multicellularity and of the presence of tissues, organs and organ systems in multicellular organisms.

Human aspect. The same principle applies to human affairs. The division of labour in human society means operational efficiency and saving of energy. But human self-interests have a tendency to exploit and produce a sense of superiority of one over the other. Actually if one man takes up one job and the other man takes up a different job, it does not make one superior to the other. It is only a mutual co-operation for the sake of operational efficiency. The exploitation and sense of superiority are retrograde steps which lead to operational inefficiency. That is why the Holy Quran holds all human beings equal by birth and worthy of respect:

(17:70) وَلَقَدْ كَرَّمْنَا بَنِيٓ آدَمَ ...

"We have honoured all human beings".

After birth there is a division of labour in human society, and the ranks are assigned to individuals according to how far one's deeds are consistent with the Divine laws; and not according to how far one can exploit the other.

وَ لِكُلٍّ دَرَجٰتٌ مِّمَّا عَمِلُوْا ... (46:19)

"To all are (assigned) ranks according to deeds".

The more one follows the Divine laws, the more he fits into the machinery of nature and promotes the operational efficiency of human society.

SPECIES

A few individual organisms of same kind may make up a family. A number of families together make a herd or tribe. Next higher organisation where the number of organisms of same kind is very large and which occupy a given area is called a population. Pines of a forest or the people living in a village are examples of local population. Huge populations of animals and plants exist. For example, protozoa may exceed 1,000,000 per litre of sea water. The sum of all populations of the same kind forms a species. A species may be defined as a group of organisms structurally and functionally similar, are derived from a common ancestry and can breed with one another to produce fertile offspring. But individual variations do occur amongst members of a species and this is known as polymorphism. Sexual differences between males and females of same species is an instance of di-morphism, a form of polymorphism.

SOCIETIES

In some cases a population is a far more closely knit group, the unifying link being not only inter-breeding but the individuals live together in an integrated manner, so that each contributes in some special way to the welfare of all. Such special type of organisation is called a Society. Societies are a characteristic of animals, most advanced ones occur in most advanced animals i.e., in insects and vertebrates. They are highly developed among termites and in many ants, bees and wasps. Each member of an insect society is guided by an inherited instinct and is bound to follow the way shown by it. The Holy Quran calls it (وحی) revelation.

Revelation Amongst Creatures Other Than Man

Honeybee Society. In nature honeybees live in cavities of trees and rocks, though man has partly domesticated this species. The hive consists of vertical honeycomb cells of wax but some of the cells are lateral in direction and are used for storage of honey and pollen. An average hive of honeybee comprises some sixty-five thousand bees which belong to three social ranks (Fig. 29). Only one of them is a queen who is the mother of all the members of the colony. Several hundreds are drones and the rest are workers. The queen and the stingless drones are reproductive, the queen lays the eggs and the drones fertilise the new queens. The daily work and strife of the colony devolves on workers, who are asexually developed females in which reproductive system is vestigeal. They therefore do not lay eggs but spend their time carrying water, collecting nectar and pollen, secreting wax, building the combs, collecting food for all castes, attending the queen and rearing the young, and cleansing, airing and defending the hive. They gather resin from the plant buds which serves to cement and varnish crevices in the hive against wind and water. They have stings to protect the colony and its honey against robbery by other animals.

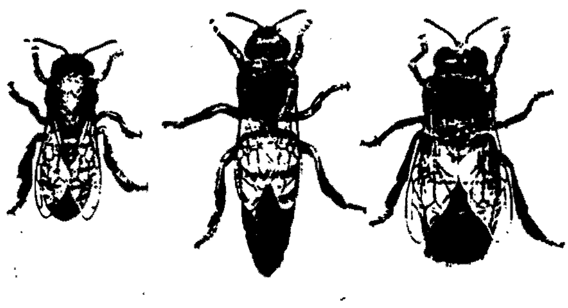


Fig. 29.—HONEYBEE.

When the warmth of spring brings early flowers, the workers gather nectar and pollen, the queen lays rapidly and new workers soon swell the colony population. Overcrowding leads to swarming. The queen and the several thousand workers emerge as a dense swarm, settle temporarily on some tree or fly to a new site previously located by worker scouts. In the old hive meanwhile the workers which remain behind raise a small batch of old queen eggs in large specially built honey-comb cells. These eggs develop into new queens. The one that emerges first, stings other larvae to death. If two queens happen to emerge at the same time they at once engage in mortal combat until one remains victorious. About seven days after emerging, the young queen mates with one of the drones in a nuptial flight high in the air; his copulatory organs are torn away to remain in her genital bursa until removed by the workers after her return to the hive. The spermatazoa thus received in her spermatheca, serve for all the fertilised eggs she will ever lay. She can control the process of fertlisation. Unfertilised development of this sort is widespread amongst social insects and a number of other animals. Fertilised eggs yield females (Diploid 32-chromosomes). In the season of nectar flow a queen lays up to 1000 eggs per day, gluing each to the bottom of a cell. For two days all the larvae are fed on royal jelly, produced by pharyngeal glands of young workers, which contains pollen, honey and large amount of vitamins. Thereafter drones and worker larvae receive mainly honey and pollen, but queen larvae continue chiefly on royal jelly which causes them to develop differently and become larger. If the queen produces eggs faster than honey-comb cells can be built, she receives less food from her attendants. Conversely if she is behind in her egg laying, she is fed more intensively.

On the food collecting trip, bees gather pollen rich in protein and nectar. Pollen is carried in pollen baskets on the legs. Nectar is swallowed into honey crop, a specialised part of alimentary canal. A worker bee on discovering food supply in the fields, fills her nectar stomach, returns to the hive and either deposits the gathered nectar or feeds the young bees. Then she executes a dance that informs other bees as to the direction and distance of the source. She moves the hind portion of the body from side to side and walks in a semi-circle, returns to the original point and makes a semi-circle in the opposite direction, again comes back, repeating several times (Fig.30). Location of food source is indicated by the specific body orientation and the distance is indicated by the number of turns in a given interval. Violence of dance gives information about the richness of food source and the nature of food supply is communicated by odour from the plant source on her body or in the nectar brought by her. Nectar held in the honey-stomach is acted upon by the salivary enzymes, cane sugar being converted into dextrose and levulose. On returning to the hive, a worker regurgitates this fluid into a cell of the comb, where the young house bees work it over in their mouths, causing further chemical changes. They evaporate the excess water by fanning with their wings. Every now and then they sample the product and when the honey is just right, the cell is sealed up with wax.

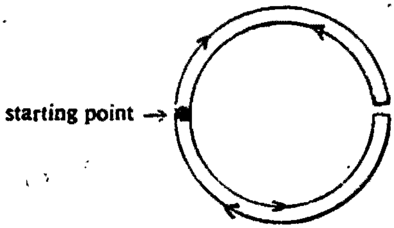


Fig. 30.—COURSE FOLLOWED BY A DANCING HONEYBEE.

Bees and other social insects possess remarkable power of orientation. On food collecting trips bees have been shown to navigate by the sun. They are able to relate the position of their hives with the direction of polarised light coming from the sun, hence they may steer a beeline course home from any compass point. In winter bees gather together in compact masses as a protective measure against the effects of cold. When exposed to smoke they rush to their food stores and gorge themselves with honey. As a safeguard against food shortage, the drones are expelled from the colony at the approach of winter. Reactions like these appear to be well thought out, yet they are not the outcome of bee's intellect. These along with many other functions described above are due to instinct which according to the Holy Quran is a form of revelation.

The Holy Quran repeatedly lays stress on the point that the laws operating in the physical world and those operating in the living world arise from the same source and secondly that the guidance to the living creatures as well as to the inanimate objects is provided by means of revelation وحى . The physical world gets direct guidance by means of physical laws which are ingrained in the very substance of inanimate objets, by the Creator. The animal world gets direct guidance by means of physical laws and instincts. Human physical body gets direct guidance like all other animals by means of physical laws and instincts. Human personality, on the other hand gets indirect guidance through the messengers of Allah. Thus in the verses that follow, the word (وحى) 'revelation' has ben used for the guidance that has been placed in the bee by way of instinct:

وَاَوْحٰى رَبُّكَ اِلَى النَّحْلِ اَنِ اتَّخِذِىْ مِنَ الْجِبَالِ بُيُوْتًا وَّمِنَ الشَّجَرِ وَمِمَّا
يَعْرِشُوْنَ ۝ ثُمَّ كُلِىْ مِنْ كُلِّ الثَّمَرٰتِ فَاسْلُكِىْ سُبُلَ رَبِّكِ ذُلُلًا يَخْرُجُ مِنْ بُطُوْنِهَا
شَرَابٌ مُّخْتَلِفٌ اَلْوَانُهٗ فِيْهِ شِفَآءٌ لِّلنَّاسِ اِنَّ فِىْ ذٰلِكَ لَاٰيَةً لِّقَوْمٍ يَّتَفَكَّرُوْنَ ۝ (16:68-69)

"And thy Lord placed in the bee His guidance (i.e., gave her instinct) to build its hives in hills and in trees and from where to control (its operations). Then to eat of all kinds of fruits and obediently follow the path of thy Rabb. Then comes forth from their bellies a drink of varying hues wherein is healing for mankind. Verily in this is a sign for those who think over it".

It is a charming description of the control posts of bees, located inside the honey-comb cells and of the collection of honey which serves as a cure for human ailments. In the above-said verse is another instructive sign as to how the Creator of the universe controls the sustenance of living organisms. Indeed in the honeybee society there is a guidance for mankind. To man she is a symbol of industry and co-operation. How the bees collect, store and distribute food for the benefit of society as a whole! How the food is provided according to individual requirements and how its economy is controlled according to availability in different seasons! How a worker bee strives hard for the whole day, and after collecting food, consumes only that much which is sufficient for her individual requirements and deposits the rest in a common pool, for the welfare of others! How the egg-laying is controlled according to the number of workers needed at a particular time! How accurately the labour is divided amongst individuals and how the lethargic drones not contributing to the welfare of the society are turned out of the hive during periods of stress!

The human ailments are self-created, partly due to lethargy and parasitism of certain individuals and mainly due to the maldistribution and mishandling of the means of sustenance. In the honeybee society there is a lesson and a remedy for human aliments.

The word سبل in the above verse indicates the remarkable power of orientation placed in the bee by the Creator of the universe. The word has been used in various other contexts in the Holy Quran. As for example:

اَلَّذِىْ جَعَلَ لَكُمُ الْاَرْضَ مَهْدًا وَّجَعَلَ لَكُمْ فِيْهَا سُبُلًا لَّعَلَّكُمْ تَهْتَدُوْنَ ۝ (43:10)

"He has made for you the earth a cradle and He made routes therein, in order that you may find guidance".

The verse points out that the earth provides rest as well as freedom of movement over the land routes and airways. Man moves from one place of the globe to another by his skill of navigation which he has gradually developed with the increase in intellect. He is guided by various landmarks which provide him direction by the day and the stars provide him direction during the night when the landmarks are invisible.

هُوَ الَّذِىْ جَعَلَ لَكُمُ النُّجُوْمَ لِتَهْتَدُوْا بِهَا فِىْ ظُلُمٰتِ الْبَرِّ وَالْبَحْرِ ..

(6:98)

> "It is He Who made the stars for you, that you may guide yourselves with their help, through the dark spaces of land and sea".

At yet another place it is said:

وَاَلْقٰى فِى الْاَرْضِ رَوَاسِىَ اَنْ تَمِيْدَ بِكُمْ وَاَنْهٰرًا وَّسُبُلًا لَّعَلَّكُمْ
تَهْتَدُوْنَ ۝ وَعَلٰمٰتٍ ۚ وَبِالنَّجْمِ هُمْ يَهْتَدُوْنَ ۝

(16:15-16)

> "And He has set up on the earth mountains standing firm, so that it moves with you; and streams and routes that you guide yourselves. And landmarks and by the stars that they may guide themselves".

The guidance in the verses described above, appears to be both for human being and for other animals; because in the verse 16:15 it is the second person and in the verse 16:16 it is the third person that is addressed to.

In addition to the natural landmarks man has invented various navigational instruments. But the navigational skill is extremely well developed in birds, insects and marine creatures. The birds take yearly journeys that span whole continents and oceans. They travel thousands of miles without making a slightest mistake in direction. The food collecting trips of bees has been described above and the navigational skill of marine creatures shall be described now. This indicates as to how the same law works in two different ways, in animals through instinct and in man through the agency of intellect and judgement.

Vertebrate Societies. Now let us study some more interesting phenomena related to revelation amongst animals. We noted earlier that polymorphism in insect societies is structural as well as functional. For instance, queens, drones, and workers amongst honeybees are different both structurally and functionally. Polymorphism in vertebrate societies on the other hand is predominantly functional and behavioral. It may be based on variations in physical strength, or in developed skills, or in mental acuity. But in any case the behaviour is based on inherited instinct. The vertebrate societies are organised in the form of families or herds. For example, flocks of birds, herds of deer and shoals of fish are among the most primitive societies. In a herd of deer, while travelling, males usually guide the group by rotation, one leads at a time, others being stationed at the outskirts of the group. This sort of association has a protective function. Social life amongst beavers* is more advanced and co-operative. Beavers are remarkable for the skill and industry with which they construct dams of wood and mud. Several families may pool their efforts in wood cutting and dam building. It is a common observation in this part of the world that crows gather from about 20-30 miles distance at central places in jungles, for shelter during night time. Their association is mainly protective.

Flocks and herds of social animals often migrate from one place to another, in search of food, in response to seasonal changes in climate or to reach geographically fixed breeding grounds. Long range migrations are common among many types of birds, eels and seals. The distance between the breeding areas and wintering areas of some birds is several thousand miles. For example, black and white cuckoo (Koel) breeds in Indo-Pakistan subcontinent and its wintering area is in East and South Africa, distance of 3500 to 4500 miles. When not migrating, these animals are dispersed over a vast territory. At specific times they gather together from far and wide at a rendezvous and then travel together to their destination in a compact group. These occurrences are most puzzling. It is difficult to imagine how these animals come to know their place of rendezvous and how do they know the exact time of arrival there? How do they reach their destination thousands of miles away without making a slightest mistake, especially in cases where none of these migrating animals has ever been there before. The phenomenon of Eel migration shall illustrate the point.

Eel is a snake-like fish (Fig. 31a). Both American and European eels lay their eggs in the deep waters of Sargasso Sea (South East of Bermuda and North East of Puerto Rico, in the Atlantic Ocean) (Fig. 31b). The eggs turn into minute larvae or elvers which then travel towards the respective coasts, the larvae of American eels turn west and those of the European eels turn east. The larvae of American eels reach the American coastal waters in about a year and their maturation also takes one year.

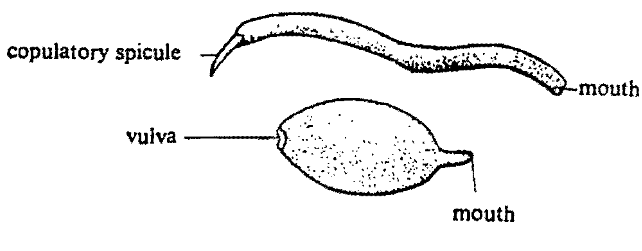


Fig.31a.--EEL (snake-like fish)
Adult male above; adult female (cyst) below.

Larvae of European eels take three years to reach the European coast and their maturation time is also three years. In coastal estuaries (mouths of rivers) the larvae

*A beaver is an amphibious rodent with broad oval horizontally flattened tail, webbed hind feet, soft fur and hard incisor teeth with which it cuts down trees. In Urdu language it is known as 'OODBALAO'.

change into adults. Adult males stay there while the females travel upstream along the rivers and settle in head waters and lakes. After about a decade, the females return to the esturies, rejoin the males and again proceed together towards the Sargasso Sea. On arrival, the females lay eggs and males fertilise them. After fertilisation the males die. It is a most intriguing phenomenon. How do, minute nearly microscopic, immature larvae find their way to the coastal waters and reach the estuaries from where to ascend the rivers? How a decade later when they are mature adults, they find their way back to the breeding place. The phenomena described above are certainly not the outcome of learning or intellect. It is a guidance from the Creator of the universe which the Holy Quran describes as (وحی) revelation.

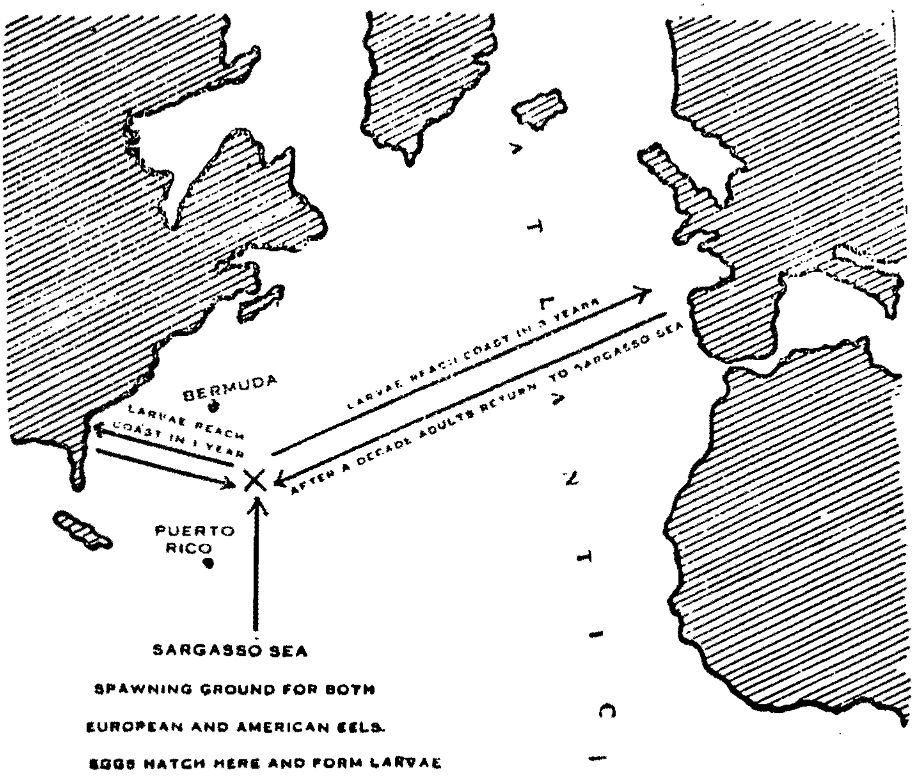


Fig.31b.--MIGRATION OF EELS. *(Instinct)*...... وحی

It indicates the presence of a Supreme controlling power, a Supreme law-giver Who initiated the laws and executes them in various ways. To believe in authorities other than that Supreme Authority is most imprudent. that is why the Holy Quran says:

(16:17) اَفَمَنۡ يَّخۡلُقُ كَمَنۡ لَّا يَخۡلُقُ ؕ اَفَلَا تَذَكَّرُوۡنَ ۝

"Is that He Who creates like one that creates not? Will you not take hint and understand?"

Human Society. In Sociology the term Society means a changing pattern of social relationship. The pattern here is not an inherited instinct; it is not fixed as in the case of animals, who have got no choice of their own.

The social relationships are differentiated from the physical relationship. There is a relationship between atoms of hydrogen and oxygen. Each of these is affected by presence of the other. But this relationship is not social one, because the psychical condition is lacking. The atoms of hydrogen and oxygen are not aware of the presence of one another. Yet the result produced by their mutual reaction is exact and constant; and that is the production of water, an object of higher formation.

The conflict amongst the members of human society results in disorder which hinders the smooth evolution of Man to a higher formation. Yet it is possible to achieve that objective, if man uses his faculty of "freedom of choice between right and wrong" in the right direction. The steer for the right direction is provided by the Divine guidance which originated from the same source as the laws governing the physical world.

COMMUNITIES

The highest organisation in the living world is Community. It is a local association of populations of several different species. For instance, all the people, domestic animals, trees, grasses, bacteria and all other organisms in a certain locality form a community. A community always contains animals as well as plants, as their survival is interdependent. In every stable community green plants manufacture their own food. Herbivorous animals eat the plants. Carnivorous animals eat the herbivores; they also eat each other. The waste products and the products of decomposition of dead bodies of animals and plants, return to the soil and the sea water. With the aid of solar energy, the raw material again causes the growth of new plants.

CHAPTER IX

Environments and Nutrition

كَيْفَ تَكْفُرُونَ بِاللَّهِ وَكُنْتُمْ أَمْوَاتًا فَأَحْيَاكُمْ ثُمَّ يُمِيتُكُمْ ثُمَّ يُحْيِيكُمْ ثُمَّ إِلَيْهِ تُرْجَعُونَ ۝ (2:28)

"How can you deny the divine laws, seeing that there was no life on the earth (76:1), then life appeared and going through the process of evolution man came in to being. Then He will cause you to die and again bring you back to life and again to Him you will return."

... يُخْرِجُ الْحَيَّ مِنَ الْمَيِّتِ وَمُخْرِجُ الْمَيِّتِ مِنَ الْحَيِّ ... (6:96)

"It is the Divine law that causes the living matter to spring from the non-living and the non-living to spring from the living one."

Changes in the earth's environments and their effects on life

The environments are never stable. The physical world goes on changing, at every scale from submicroscopic to global. Various physical and chemical forces from outer space and from within the earth itself change every bit of the earth's substance, inorganic as well organic. The exchange of matter between earth and outer space is negligible. But enormous amounts of energy both enter and leave the earth. The screened solar energy after passing through the atmospheric filter reaches the earth in the form of ultraviolet, light, heat and wireless rays and the energy that radiates out from the earth is mainly in the form of heat. The energy flux constantly keeps disturbed the earth's matter which is never in a state of static equilibrium.

The Holy Qurans described 1400 years ago:

هُوَ الَّذِي خَلَقَ السَّمَاوَاتِ وَالْأَرْضَ فِي سِتَّةِ أَيَّامٍ ثُمَّ اسْتَوَىٰ عَلَى الْعَرْشِ ۚ
يَعْلَمُ مَا يَلِجُ فِي الْأَرْضِ وَمَا يَخْرُجُ مِنْهَا وَمَا يَنْزِلُ مِنَ السَّمَاءِ وَمَا يَعْرُجُ فِيهَا ... ۚ
(57:4)

> "It is He Who created the heavens and the earth in six eras and is firmly established on the throne of authority. *He knows what enters the earth and what comes out of it, what comes down from heaven and what mounts up to it."*

These environmental changes which occur in rhythmic patterned cycles are produced primarily by the heat of the sun and the rotation of the earth. Seasonal climatic changes are well known to all of us. But we may not be able to observe directly other environmental cycles, as their scale may be too big or too small, or they may occur too fast or too slow.

Living matter is interposed between these cycles and as the earth's components circulate, some of them become raw materials for the use of living matter. As noted already, a living organism is composed of both inorganic and organic matter and it requires both, for the maintenance of life. Any chemical that a living body requires as raw material is called a Nutrient. Organic nutrients are also called Food. The inorganic nutrients are withdrawn by the organisms directly from the physical environments and are used for the manufacture of organic metabolites inside their bodies. During lifetime the breaking-up processes go on side by side with the making-up processes and the organisms excrete waste products which are returned to the environment in the form of inorganic matter. After death the entire body of an organism undergoes decay which is caused by the saprotrophic becateia and fungi. The organisms are thus retransformed into the same inorganic materials from which they were originally built, and which are returned to the environment, to be re-used as nutrients by some other organisms (Fig. 32).

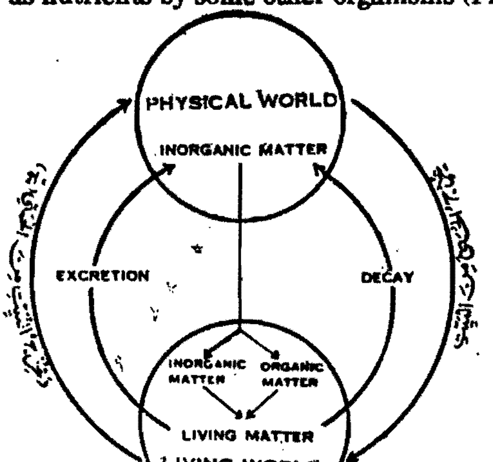


Fig. 32.—PHYSICAL WORLD AND LIVING WORLD.
Inorganic matter and living matter give rise to each other in a cyclic order.

Living organisms may therefore be considered as transient constructions built out of materials borrowed temporarily from the environments. The physical earth thus inspite of its contribution to the formation of living organisms, conserves all its material on long-term basis and makes possible for life to be recreated indefinitely. Therefore the continuity of life depends upon the parallel continuity of death.

The life involving cycles become part of and often reinforce and contribute to the physical cycles on the earth. As in purely physical cycles, those in which living matter participates, run on energy supplied by the sun. Solar energy is trapped by living organisms via photosynthesis and some of this energy is later used by organisms in moving components of the earth through their bodies. The global environments consist of three main segments--(1) The Hydrosphere which includes all liquid components i.e., water in oceans and on land. (2) The solid part of the earth i.e. the rocky substance of the continents form the Lithosphere. (3) And the Atmosphere or the gaseous covering which surrounds the Hydrosphere and the Lithosphere.

THE HYDROSPHERE

Of all the minerals of the planet earth, water is the most abundant one. Nearly three-fourth of the earth's surface is covered with water, and it is also contained in large amounts in the atmosphere and the lithosphere. It is also the major component of living matter. The basic water cycle is quite familiar. Heat of the sun evaporates water which is thus transferred from the hydrosphere into the atmosphere. the evaporated water cools and condenses, when it reaches. high altitudes. Clouds are formed and after precipitation as rain or snow, water is returned to the hydrosphere. This is the most massive process of any kind on the earth, consuming more energy and moving more material than any other.

Hydrosphere affects metabolism in two different ways:--(1) It affects world climate and thus affects life and metabolism indirectly. (2) It serves as a nutrient to living organisms and thus affects metabolism directly.

Effects of Hydrosphere on climate. For this we shall have to study what the oceanic environments are like:--

Beneath the surface of the oceans, there is no uniform mass of water but a series of well defined layers, each with its own characteristics such as salt contents, temperature and marine life. Coursing through these layers are fast currents some of them hundreds of miles long and up to one hundred miles wide. These currents affect the world climate, for a change in the direction of the current can alter weather far inland. The ocean currents are caused by three main forces:--(1) The differences in the sea's density (2) The prevailing winds (3) The earth's rotation.

(1) Differences in sea's density -- Convectional currents have already been described in Chapter III. In the oceans water warmed in the tropics becomes light and rises to the surface, whereas cool polar water sinks. These up-down displacements bring about massive horizontal shifts of water between equator and pole (Fig. 33). On the other hand, in the oceans, when two bodies of water with different salt quantity and different temperatures meet, they do not mix with each other but keep separated by sharply defined line. The cold wall between the Labrador current and Gulf Stream may be taken as an example.* Where currents converge or diverge, where cold or salt water sinks beneath the water that is less dense, a circulation is set up which may penetrate to the ocean bottom. Surface water is replaced by upwelling water rich in salt contents.

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*Labrador is eastern coastal part of large peninsula of extreme north-east America, between Hudson Bay and Atlantic; formerly a dependency of Newfoundland but now a part of Canada. The current of cold water from Arctic ocean moving southwards along this part of east coast of north America is called LABRADOR CURRENT. On the other hand, the great oceanic current of warm water flowing from Gulf of Mexico parallel with the American coast to Newfoundland is called GULF STREAM. The sharp division between these two converging columns of water at their line of junction is known as COLD WALL.

(2) The other factor which reinforces the ocean currents is the air movement. The wind producing air movements on the pattern of water currents are the result of certain thermal properties of water. Of all liquids water is one of the slowest to heat or cool and it stores a very large amount of thermal energy. The oceans thus become huge reservoirs of solar heat. The result is that sea air chilled by night becomes less cold because of heat radiation from water warmed by day. On the other hand, sea air warmed by day becomes less hot because of heat absorption by water cooled by night. Warm and cool on-shore winds then moderate the inland climate in daily pattern. Analogous but more profound effects are produced by radiation and absorption in seasonal summer and winter patterns.

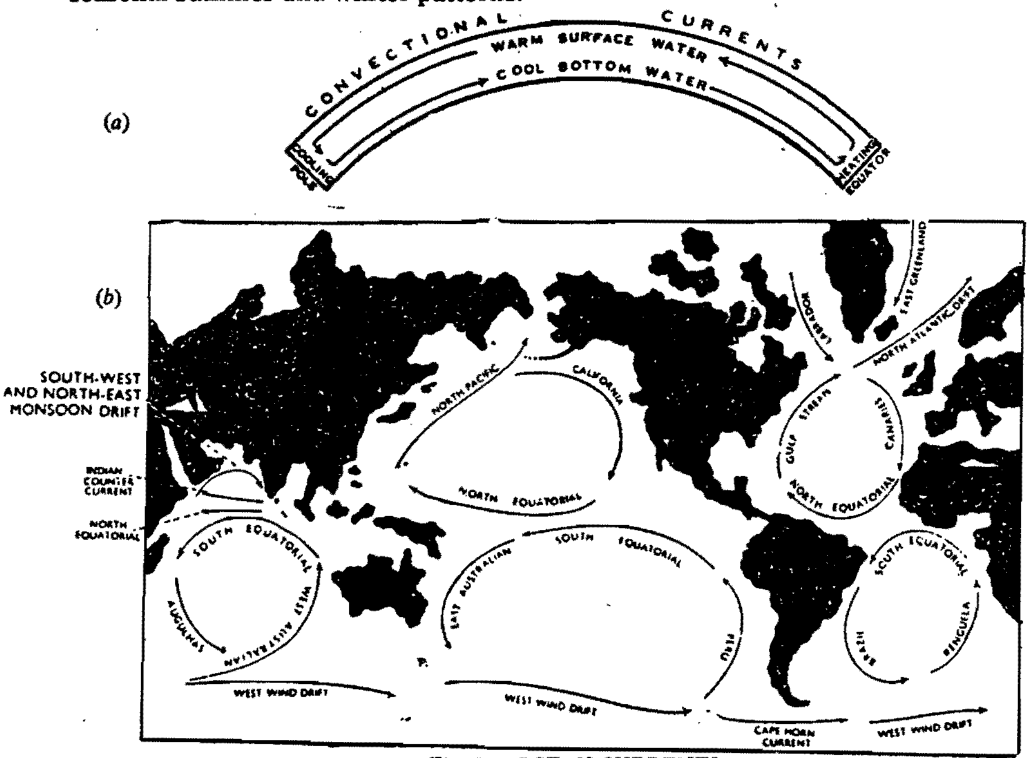


Fig. 33.--OCEAN CURRENTS

(a) The depth circulation of ocean water. Water warmed in equatorial regions rises and water cooled in polar regions sinks.

(b) The basic equator to pole circulation shown in (*a*) above is modified by the rotation of the earth, by winds and by the position of the continents. Thus the actual circulation of ocean water is as shown in (*b*) above.

(3) The third factor which affects the ocean currents is the rotation of the earth. The rotation deflects moving things to the right in the northern hemisphere and to the left in the southern hemisphere. This causes the ocean surface currents to move in a clockwise or anticlockwise direction.

The hydrosphere also *affects the world climate in another way*. The global climate over long periods of time is determined by the relative amounts of water locked in the polar ice. There is a temperature variation of only a few degrees over the years which causes the polar ice to retreat. Though it is not yet understood how it occurs. During the last one million years ice ages have gradually appeared and then disappeared, intervened by interglacial periods with ice-free poles. Four such glaciasl cycles have occurred, each lasting for about 60,000 to 200,000 years. At the present time the earth is gradually coming out of the last ice age, which reached its peak 50,000 to 20,000 years ago. The earth is now gradually warming up and with the melting of polar ice the water level of oceans is rising up, the coastal lines are gradually being submerged. Deserts are expanding and the snow on the mountains is receding to high altitudes. This change in climate has a profound effect on the flora and fauna of the world.

Direct effect of hydrosphere on metabolism. Water is the major inorganic nutrient required by all living matter. In metabolism water is the only source of element hydrogen and one of the two sources of oxygen. In using water as metabolite, organisms withdraw it principally from the hydrosphere. Land animals draw water present in the soil and fresh water tracts. They circulate water through their bodies and retain a certain quantit. The rest is excreted and returned to the environment; as for example, man excretes liquid water through urine and perspiration, and water vapours through breath. Living organisms pass on water much more faster from hydrosphere to atmosphere than if the water were allowed to evaporate directly from the hydrosphere. Under certain conditions it affects climate. For example, the trees of tropical forests release so much water that the air over the vast areas remains permanently saturated with moisture, cloud burst occurring almost every evening. It is a common experience in the forests along the western 'ghats' of India.

After death the land animals decay and the water from their bodies returns to the hydrosphere.

We noted above the influence of various cyclic changes in the hydrosphere on temperature, humidity, rainfall, winds and currents etc. These factors and even the very presence of water in certain locality determine what kinds and amount of organisms may live there.

Oceanic Environments and their effects on Life. We shall deal with the life on land later. Let us describe briefly at this juncture the life in the sea. Life originated in the sea. All categories of animals including mammals, the warm-blooded group to which man belongs, are present in the sea. True fish are in a relatively small number. About 20,000 sea fish species are known. On the other hand there are 40,000 known species of mollusc (the group which includes oysters, mussels etc.). In the sea, as on land, life depends largely on plants and the plants of the oceans are almost as productive acre per acre, as the plants on land. The pastures of the sea and the basis of its life cycle are countless free floating, microscopic plants known as

Phytoplankton. These are the food of minute animals called Zooplankton. Zooplankton are preyed upon by larger animal species, which themselves provide food for still bigger creatures. Thus, eat and be eaten, is the rule of the sea. The plants in turn are nourished by the minerals, derived in part from the decay of marine organisms. A never ending cycle thus continues.

Distribution of life in the sea depends upon various factors; such as water currents, salinity, temperature, presence of light and pressure etc.

Since most plants require sunlight for their survival, marine plants grow only within 300 feet of the surface of water. A large part of the sea life is therefore confined to this topmost layer, which is continuously being fertilised by the upwelling water currents rich in salts. Beneath the 300 feet layer, life is sparser and creatures need special equipment for survival. Thus Angler fish with huge expanding stomachs can swallow creatures larger than themselves and thus make one meal last a long time. Other fish, like Gigantura, have very sensitive tubuler (telescopic) eyes that help them see their prey in the near darkness. Perhaps the most remarkable adaptation to life in the deep, is that of certain deep-sea Angler fish (Fig.34). Their reproduction depends on but one chance meeting in the barren depths, after which the female carries the male permanently with her. The male is much smaller and parasitic on his partner.

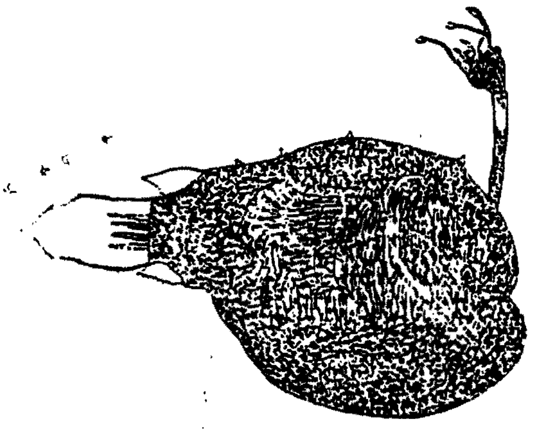


Fig. 34.—DEEP-SEA ANGLER FISH.

But on the whole the adaptation to environment and specialisation in forms has not gone very far in oceans as compared with the land animals. This is because the oceans do not have the harsh seasonal and regional contrasts of land. Surface temperature in any one region seldom varies more than a few degrees, and fish whose body consists largely of fluid at the same temperature as their surroundings, do not therefore need any particular mechanism for keeping warm or cool. Again the liberal development of wings, limbs and other organs needed on land to overcome the burden of gravity, is un-necessary for creatures that float on water.

As few sea-animals have mechanisms such as sweat glands, for adapting themselves to changing conditions, they are sensitive to slight variation in their surroundings. With some exceptions, such as sharks and whales, each species is confined to its own particular zone, where pressure, light, temperature and the salt quantity in water, are more or less constant. In this stable environment some creatures have remained unchanged in their entire history. For example, Coelacanth, one of a group of fish, which is accepted as the ancestor of all land animals, extinct since Cretaceous period (60 million years ago) except one genus (Latimeria) found in South-East African seas.

Fresh water. Unlike salt waters in oceans, seas and bays, the fresh waters lie scattered over the land and in the soil.

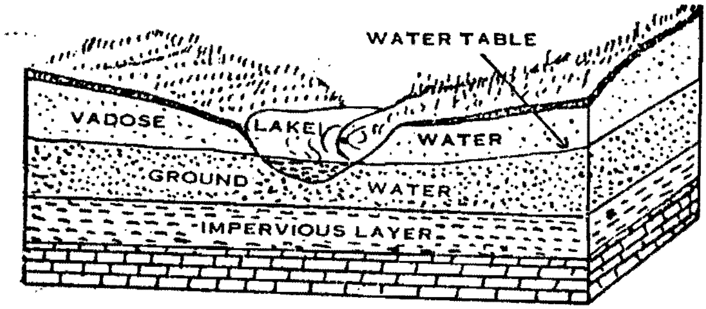
Fresh surface water. Fresh water may be running or standing. Cold mountain water streams, spring-fed brooks, slower brooks and creeks, and rivers of various sizes contain mobile animals that are segregated according to the rate of water movement, temperature, oxygen content and character of the bottom. Thus trout live in cool well-oxygenated waters whereas carp thrive in warm and even foul waters. Inhabitants of rapid waters are often flattened or have no means for holding to the bottom

Standing waters comprise lakes, swamps marshes and bogs. Large lakes afford more stable environments than running waters.

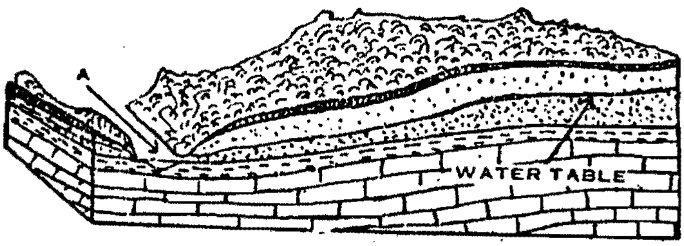
Ground water (or Subsurface water). Ground water is another source of fresh water. It occurs in permeable geological formations known as Aquifers. An aquifer is a stratum of rock which can hold water in its mass, like a sponge; e.g., chalk, limestone and sandstone. A well may be sunk to tap this stratum. Ground water is a portion of the hydrological cycle. In moist regions the rain usually wets the soil as far down as it is porous and then accumulates on the first impervious layer (Fig.35-a). Near the surface the soil is not soaked or saturated with water but it is moist or damp because the surfaces of the grains of sand and clay are wet. The spaces between the particles in this region of *Vadose water* are filled with air. If they are filled with water, the soil is not fertile. Further down the *water* collects over a layer of impervious rock and wets the soil thoroughly, so that there are actual drops of water between the grains. This is *Ground water*. The line separating the vadose water from that of ground water is called the *Water Table*. In general the water table is more or less parallel to the surface of the ground, but if the ground slopes, then gravity will cause the water to move down towards lower levels, but it will move very slowly (Fig.35-b). Whenever a water table intersects the ground surface, water comes out of the ground and a body of water will collect to form a pool, a swamp, a lake, or a river, if the water flows out in a current, it is called a spring (Fig.35-b and c).

Sometimes the impervious rock has unusual shapes and therefore the water table will be unusually irregular and fantastic. The water table is not fixed in its position but varies greatly. When it rains the water table rises, during periods of drought it falls down. Ground water has been found in rocks as far down as two miles, but this is due to cracks rather than porosity.

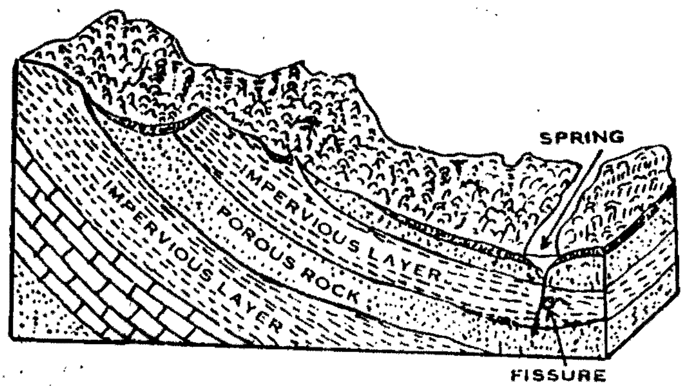
Movements of ground water. Thus we noted that water originates as surface water and the permeable formations in the earth's crust serve as conduits for transmission and as reservoirs for storage of water. Essentially all ground water is in motion, velocities range from a few feet per day to only a few feet per year. Water infiltrates into the ground from natural recharge of precipitation, stream flow and



(*a*) Water Table.



(*b*) Sloping Water Table.
(A—a spring, a pool, a swamp, a lake, or a river may form here.)



(*c*) Fissure Spring.

Fig.35.--GROUND WATER.

lakes. In addition efforts by man constitute artificial recharge. When a zone of saturation is reached, the water flows in a direction controlled by the hydraulic boundary conditions, as the system of rocks in which it is situated, may be simple, irregular, complicated, level or sloping etc. The discharge is mostly into the surface water bodies, such as lakes. Spring flow and evaporation are other methods of discharge. Pumping of wells is the artificial discharge method. Thus a constant cycle goes on from surface water to ground water and from ground water to surface water.

Dyes, electrolytes and radio-isotopes are used as tracers for detecting the movement of ground water. The rate of flow through a sand aquifer is directly proportional to the head loss and inversely proportional to the thickness of the sand traversed by the water.

Destruction work of Ground Water. The movements of underground water rarely produce the same results as in erosion by surface water stream. The chief processes by which subsurface water acts are oxidation and solution. Pure water alone has little effect on rocks. The only two which are soluble are rock salt and gypsum. But water containing oxygen and carbon dioxide readily attacks rocks containing particularly the elements calcium, magnesium and iron. Water containing dissolved calcium and magnesium salts is called *Hard Water*. Such water may be softened by boiling or by adding washing soda.

Human Aspect. The masses of water on the globe are beneficial for humanity in one way or the other. The oceans of the world, large rivers, and big lakes form highways for shipping and commerce, unparalleled by any other means of carrying freight. Both sweet water and salt water produce variety of fish which is one of the sources of nutrition and a palatable food for man . There are also substances of ornamental value for man found in the depths of the seas and the river beds. As described above, molluscs form the majority community of sea life. Concretions, commonly known as pearls, usually of white or bluish grey colour, are formed round foreign body, within shell of oyster (margaritefera), a genus of bivalve mollusc. The other substance used as ornaments, found under sea water, is coral. This is a hard calcareous substance consisting of the continuous skeleton, secreted by many tribes of submarine coelenterate polyps, for their support and habitation (Fig. 36). On the other hand, gems such as Carnelian (AQIQ), agate, the goldstone and other varieties are found in river beds. These substances together with other gems formed in the depths of earth's crust are, like so many other wonders of the material world, the manifestation of the highest architectural skill of the Creator of the universe.

Fig. 36.—CORAL.

The Holy Quran describes the above-said phenomena in the following words:

وَمَا يَسْتَوِي الْبَحْرٰنِ ۖ هٰذَا عَذْبٌ فُرَاتٌ سَآئِغٌ شَرَابُهٗ وَهٰذَا مِلْحٌ
اُجَاجٌ ۗ وَمِنْ كُلٍّ تَاْكُلُوْنَ لَحْمًا طَرِيًّا وَّتَسْتَخْرِجُوْنَ حِلْيَةً تَلْبَسُوْنَهَا ۚ
وَتَرَى الْفُلْكَ فِيْهِ مَوَاخِرَ لِتَبْتَغُوْا مِنْ فَضْلِهٖ وَلَعَلَّكُمْ تَشْكُرُوْنَ ۝

(35:12)

> "Nor are the two bodies of flowing water alike, the one palatable, sweet and pleasant to drink and the other salt and bitter. Yet, from each kind of water you eat flesh fresh and tender, and extract ornaments to wear and you see the ships therein that plough the waves; and that you may seek His bounty, and that you may steadfastly follow His Law."

As already noted, the types of organisms differ with the type of water they live in. On the other hand the life on the land depends on the presence of fresh water. The phenomenon of keeping separate the salt water and fresh water, in spite of their free access to each other is described by the Holy Quran as follows:

وَهُوَ الَّذِيْ مَرَجَ الْبَحْرَيْنِ هٰذَا عَذْبٌ فُرَاتٌ وَّهٰذَا مِلْحٌ اُجَاجٌ ۚ وَجَعَلَ
بَيْنَهُمَا بَرْزَخًا وَّحِجْرًا مَّحْجُوْرًا ۝

(25:53)

> "It is He Who has let free to intermingle two bodies of moving water, one palatable and sweet and the other intensely bitter. Yet, He has made a barrier between them, a partition that is forbidden to be passed."

The verse above, as interpreted by most of our commentators gives the impression of two rivers, one of sweet water and the other of salt water flowing side by side in contact with each other and yet one not mixing with the other. This explanation is not supported by natural evidence. On the other hand, it is true that huge moving columns of water do exist inside the oceans which when come into contact with each other, do not intermingle because of their difference in temperature and density (salt contents) as for example, Labrador current and Gulf Stream, when they come in to contact with each other, in the Atlantic ocean.

A book entitled, "Dardanelles Patrol" by Peter Shankland and Anthony Hunter, describes an interesting event of 1915 A.D., when British submarine E-11 entered the sea of Marmara through Dardanelles and attacked the Turkish vessels, to cut the supply line to Gallipoli peninsula. At one point the submarine E-11 did not go below 70 feet in water and did not answer the hydroplanes inspite of using all possible means to bring it down. After a long trial the commander ordered all engines to be stopped. There were curious noises overhead for about two hours. Abruptly they ceased. The commander took the boat off the bottom and found her in perfect trim and answering to the controls as if she had never given any trouble. The commander of the boat repeated the experiment next day in order to find out the cause of the incidence. He brought the boat to the position which had already been marked on the chart. He ordered diving stations and repeated the previous day manoeuvre. He took E-11 in long gradual dive to seventy feet. Again the coxswain reported that the boat would not go any lower. The boat was going ahead, the hydroplanes were hard down but she would not go down. He flooded the auxiliary and let in three tons of sea water ballast. It had not effect. He let in three more and another three, still she would not go down. The coxswain put the hydroplanes hard up but the boat would not come up, as if she was weighted down by nine tons of extra ballast. If you can not go down and you can not go up, then stop every thing the commander said; the engines stopped; the boat gradually lost way. There was dead silence. Only one man was kept on watch. He had to call at once if the depth altered. It was for the first time, it had ever been heard of for a submarine to lie suspended. It was still at the depth of 70 feet and there were more than two hundred feet of water underneath them, between the keel and the sea bed. The commanders discovery was that instead of there being a gradual or a fairly rapid change in density, as he had imagined it, there was a rigid line of demarcation. برزخ - The layers slid over each other usually moving in different directions, but not inter-mingling. The submarine in the fresh water layer was now resting on the surface of heavier salt water as solidly as if she were on the bottom.

Is it not remarkable that the Quran pointed towards this phenomenon fourteen hundred years ago when it was said, "It is HE who let free to intermingle two bodies of moving water, one sweet and palatable and the other intensely bitter, yet it has made a barrier between them, a partition that is forbidden to be passed.

But there is another point which comes in to mind that although huge columns of water with different densities (salt contents) exist in the ocean, yet they all consist of salt water. No such thing as sweet and palatable water exists in the seas, nor a phenomenon of sweet and salt waters running side by side and yet not mixing with each other exist on the land.

An alternative explanation is possible which is as follows--

The بحر means massive quantities of water, whether in the oceans or any where else. The hydrological cycle ensists of two segments. The salt water which lies in the oceans forms one segment or one part of the cycle. The water vapours that emerge from the oceans, by the heat of the sun, the clouds, the precipitated water from the clouds that reaches the ground surface in the form of rain, the surface water (including the mountain streams, rivers and lakes etc.) and the subsurface water, which ultimately drain in to the oceans, all together form the second segment of the hydrological cycle. The rain water as we know, comes in to contact with the gases and rocks, and the process of erosion thus gradually turns fresh water in to salt water. These two bodies of fresh water and salt water constantly move in gigantic global cycle (Fig. 37). They are free to intermingle and they do intermingle and yet they are kept apart by the physical laws of heat and gravitation which serve as a barrier (a برزخ , a حاجز , a حجرًا محجورًا) in between them.

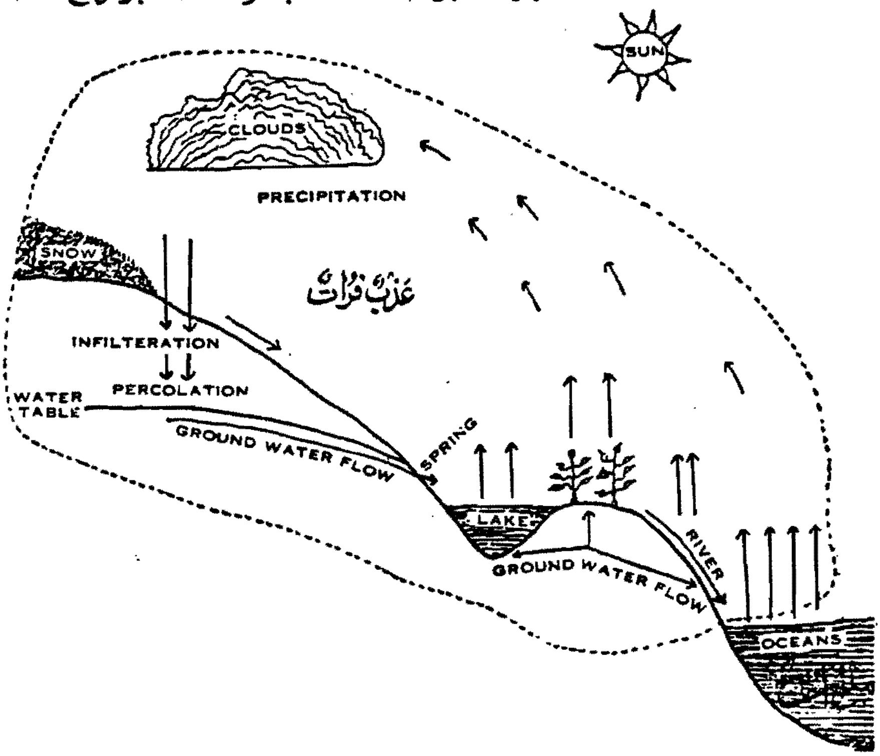


Fig. 37.—THE GLOBAL WATER CYCLE.

Fresh water (عذب فرات) and salt water (ملح اجاج) are free to mix with each other and yet are kept separate by the laws of heat and gravity.

This collosal phenomenon of the hydrological cycle and the barrier between the two segments of hydrosphere is a glorious manifestation of Allah's Rabubiyyat (provision of sustenance). But for this life in the land could not exist. The Holy Quran says:

أَفَرَءَيْتُمُ الْمَآءَ الَّذِى تَشْرَبُونَ ۝ ءَأَنْتُمْ أَنْزَلْتُمُوهُ مِنَ الْمُزْنِ أَمْ
نَحْنُ الْمُنْزِلُونَ ۝ لَوْ نَشَآءُ جَعَلْنٰهُ أُجَاجًا فَلَوْلَا تَشْكُرُونَ ۝

(56:68-70)

> "Do you observe the water which you drink. Do you bring it down from the clouds or do We? If it were Our will, We could make it salt and (bitter). Then why do you not give thanks".

It means that it was a divine plan not to allow the salinity to get accumulated in that part of the hydrosphere which is so essential for life on the land. Life on land depends on fresh water.

It may also be argued that the above said phenomenon relates to the subsurface water.

It is true that tracts of soft water and hard water do exist in the subsurface aquifers and they are kept separated from each other by the impervious rocks which may be termed as برزخ (barriers). But we must consider, firstly, that both soft and hard waters belong to the category of fresh water. The hardness in the water is temporary and can be removed by heat and chemicals. It is not reasonable to term hard water as ملح اجاج intensely bitter, which is only sea water. Secondly, that although barriers exist in between the soft and hard water tracts in the form of impenetrable rocks but the word مرج in the verse is significant. The word is used in two senses (1) To let free (2) To intermingle. The soft and hard water reservoirs in the aquifers are kept separated by rocks but are not let free to intermingle.

The role of fresh water in the maintenance of life on the earth is repeatedly impressed upon by the Holy Quran:

(6:100) وَهُوَ الَّذِيٓ اَنْزَلَ مِنَ السَّمَآءِ مَآءً فَاَخْرَجْنَا بِهٖ نَبَاتَ كُلِّ شَيْءٍ ...

"It is He Who sends down (according to His law) rain from above. And He says that with it We produce vegetation of all kinds."

اَللّٰهُ الَّذِيْ خَلَقَ السَّمٰوٰتِ وَالْاَرْضَ وَاَنْزَلَ مِنَ السَّمَآءِ مَآءً
(14:32) فَاَخْرَجَ بِهٖ مِنَ الثَّمَرٰتِ رِزْقًا لَّكُمْ ...

"It is Allah Who created the heavenly bodies and the Earth and sends down rain from above and with it brings out fruits, a means of sustenance for you."

(16:10) هُوَ الَّذِيْٓ اَنْزَلَ مِنَ السَّمَآءِ مَآءً لَّكُمْ مِّنْهُ شَرَابٌ وَّمِنْهُ شَجَرٌ فِيْهِ تُسِيْمُوْنَ ۝

"It is He Who sends down rain from above. From it you drink and out of it grows the vegetation on which you feed your cattle."

وَاللّٰهُ اَنْزَلَ مِنَ السَّمَآءِ مَآءً فَاَحْيَا بِهِ الْاَرْضَ بَعْدَ مَوْتِهَا ۭ اِنَّ فِيْ ذٰلِكَ
(16:65) لَاٰيَةً لِّقَوْمٍ يَّسْمَعُوْنَ ۝

"Allah sends down rains from above (according to His law) and gives life to the earth after its death. Verily in this is a sign for those who listen (who pay attention to the Divine law)."

The more man explores nature, the more the forces of nature become subservient to him. The Holy Qurans says:

وَهُوَ الَّذِيْ سَخَّرَ الْبَحْرَ لِتَاْكُلُوْا مِنْهُ لَحْمًا طَرِيًّا وَّتَسْتَخْرِجُوْا مِنْهُ حِلْيَةً
(16:14) تَلْبَسُوْنَهَا ۚ وَتَرَى الْفُلْكَ مَوَاخِرَ فِيْهِ وَلِتَبْتَغُوْا مِنْ فَضْلِهٖ وَلَعَلَّكُمْ تَشْكُرُوْنَ ۝

> "And it is He Who has made the sea subservient, that you may eat thereof fresh meat and that you may extract therefrom ornaments to wear. And you see the ships therein that plough the waves and you may thus seek the bounty of God, so that your efforts may bring fruit."

In the Holy Quran the order, beauty and grandeur of these mighty phenomena are appealed to. All these signs indicate that there is a Creator behind the universe who placed man in an exalted position and made the forces of nature subservient to him. Yet there are unjust, ignorant and heedless people who bow down before objects other than God:

أَمَّنْ جَعَلَ الْأَرْضَ قَرَارًا وَّجَعَلَ خِلٰلَهَآ أَنْهٰرًا وَّجَعَلَ
لَهَا رَوَاسِيَ وَجَعَلَ بَيْنَ الْبَحْرَيْنِ حَاجِزًا ۗ ءَاِلٰهٌ مَّعَ اللّٰهِ ۗ
(27:61) بَلْ أَكْثَرُهُمْ لَا يَعْلَمُوْنَ ۝

> "Or, who has made the earth a temporary abode (for living creatures); and made rivers in its midst; set thereon mountains (immovable) and made a separating bar between the two bodies of flowing water? Can there be another Allah besides God? Nay most of them have a poor knowledge."

LITHOSPHERE

Like water, the rocky substance of the Earth's surface moves in a gigantic cycle but here the rate of circulation is measured in thousands and millions of years. This has already been described in Chapter II. The rocks of the world are slowly and endlessly being re-arranged. Profound disturbances in the earth's crust give rise to mountain ranges. The early stage of this disturbance is down warping of the crust and formation of sea-filled basin in which great thickness of sedimentary rock accumulates. Later the sides of the basin move towards each other on account of the lateral pressure generated in the adjacent portions of the earth's crust, and the bottom moves up. The sedimentary rocks caught in-between are folded and slid over each other piling up into great mountain chains. The youngest and highest mountains of the present age, the Himalayas, the Rockies, the Andes and the Alps came into existence some seventy-five million years ago and the earth's crust in these regions is not settled yet. Mountain formation has a long lasting effect on climate, hence on metabolism. A high mountain barrier is likely to interfere in the continental air circulation. The moisture laden wind arising from the sea may no longer be able to pass the mountain barrier. The rainfall will therefore be on the near side of the barrier making the land fertile. The far side without rain shall become arid and desert. The fertile Indo-Pakistan on the ocean side of Himalayas and the belt of desert on the north side of it is an example. On account of different climates on either side of a newly formed mountain, different types of organisms evolve.

The second segment of the global lithospheric cycle involves the lowering of high land and the levelling of mountains called gradation. This may be brought about by physical as well as chemical forces.

Physical Forces. There may be actual geological sinking of land, or it may be due to action of water, air and sun. Water flowing down hill produces shearing canyon-cutting rivers. Water and high temperature produce humidity which corrodes the rocks. On the other hand water frozen inside the rocky crevices, when it expands by heat, cuts stones off the mountain surface. Thus water, wind and sun in time gradually reduce mountain to hill and hill to plain. This action of physical forces combined with geologic sinking may make land so low that eventually it may become overrun by the ocean.

Chemical Forces. Accompanying the physical forces of gradation are chemical forces. The water as well as the chemical substances produced by the decay of land animals and plants cause erosion of rocks. Large stones are chemically broken up into smaller ones and these in turn are broken up into tiny sand grains and microscopic and sub-microscopic particles which form the soil. Secondly, when water remains in contact with rock for some time, a portion of the rock gets dissolved into the water. When water runs down the hills, more and more mineral contents are added to it in the form of ions. When this water reaches the plains it extracts still more minerals from the soil. Thus through the medium of water these minerals become part of the living organisms; plants and animals. After death the organisms decay and the mineral ions of their bodies return to the soil. From the soil they are drained back into the rivers and eventually pass on into the ocean. The mineral compounds are thus gradually transferred from the Lithosphere to the Hydrosphere, and the salt contents of oceans gradually go on increasing. The marine organisms freely use these minerals as metabolites. When they die, their bodies sink to the bottom of sea. All organic and some of the inorganic substance gets dissolved during this descent, the rest of the undissolved solid minerals settle down at the bottom and gradually form part of the uprising rocks in the sea, which after billions of years emerge from the surface of the water to form new mountain chains.

Soil. To begin with, there was no soil on the earth. As noted already, forces of gradation turned rock in to powder. These rocky particles got washed down to the plains and settled along the banks of rivers and sea-shores as *Silt*. This got blown inland by means of winds. Early organisms monera and protista which needed no soil passed on their excretions on the surface of the earth. On death and decay their bodies turned into complex chemicals, which contributed to the organic part of the soil called *Humus*. Silt and Humus gave origin to early plants which after death and decay produced larger plants. These in turn produced more soil and still larger plants. As time passed on, more extensive and thicker layers of soil got deposited on the surface of the earth. Actually soil is not necessary for plant maintenance. Marine plants grow without soil. On land also plants can be made to grow in water rich in minerals. On land, however, soil is the cheapest store-house of minerals and at the same time it provides mechanical anchorage to the plants without any hindrance to the expansion of roots. Thus the chief functions of soil are the mechanical anchorage and the provision of water and minerals to the plants.

The above description indicates how the living organisms are interposed between the Lithospheric global cycle.

ATMOSPHERE

Physical cycle. The wind producing movements of air have already been described. The global air currents and oceanic currents move on the same pattern, the former reinforcing the latter. Air movements influence climate and thus metabolism.

The thermal property of water affecting the daily and seasonal direction of winds, cause them to circulate in global patterns; the formation of clouds and their effect on life on the earth, are described by the Holy Quran as follows:

... وَتَصْرِيفِ الرِّيْحِ وَالسَّحَابِ الْمُسَخَّرِ بَيْنَ السَّمَاءِ وَالْأَرْضِ لَآيَاتٍ لِقَوْمٍ يَعْقِلُونَ (2:164)

> "In the circulation of the winds, and the clouds which are marshalled to serve between the sky and the earth, here indeed are the signs for people who use intellect".

Again it is said:

وَاخْتِلَافِ اللَّيْلِ وَالنَّهَارِ وَمَا أَنْزَلَ اللَّهُ مِنَ السَّمَاءِ مِنْ رِزْقٍ فَأَحْيَا بِهِ
الْأَرْضَ بَعْدَ مَوْتِهَا وَتَصْرِيفِ الرِّيْحِ آيَاتٌ لِقَوْمٍ يَعْقِلُونَ ۝ (45:5)

> "And in the alternation of night and day and the fact that Allah sends down subsistence from above and revives therewith the earth after death, and in the circulation of winds are Signs for those who use intellect".

Chemical cycles. The chemical cycles of atmospheric contents are of still greater significance from the point of view of metabolism. The main constituents of atmospheric air are oxygen (20%), carbon dioxide (.03%) and nitrogen (79%). In addition water is present in varying amount and also traces of inert gases. Nitrogen, oxygen and carbon dioxide, all three circulate in global cycles and living organisms interposed between these cycles play a very conspicuous role. Atmospheric gases are also dissolved in natural waters, so that they are accessible to organisms both on land as well as in water.

Oxygen cycle. It is a common experience that living organisms inhale air, and life depends upon the oxygen present in the air. Oxygen thus enters living organisms through respiration (Fig. 38). The role of oxygen in respiration is to combine with hydrogen to produce water which joins all other water present in the body of living organisms. This water in the body of an organism gets disposed of in three different ways:--(1) It returns to the environment through excretions. For example, in mammals water is excreted through urine, perspiration etc. (2) Secondly it takes part in the formation of more living matter inside the body of the organism. Water supplies hydrogen and oxygen in the process, and oxygen thus used in the formation of building material remains there till death and after death and decay returns to the environment in the form of water or carbon dioxide. (3) Thirdly in plant life there is another fate of water present in the body of the organism. Here it is used as raw material in photosynthesis. The water is split up into hydrogen and oxygen. The hydrogen is used in the manufacture of food; and oxygen is set free to rejoin the atmosphere. Thus free atmospheric oxygen enters living organisms through respiration and rejoins atmosphere through photosynthesis. In the intermediary stages, inside the body of the organism it is incorporated in water and through it either enters the water cycle or after being incorporated in building material, enters the carbon cycle.

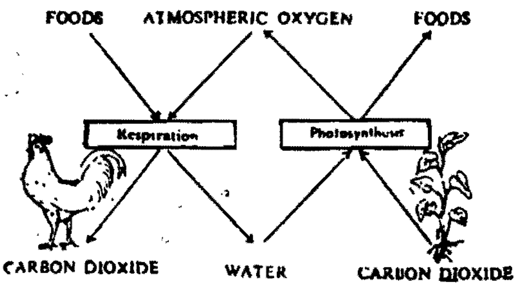


Fig. 38.—THE OXYGEN CYCLE.

As noted already in Chapter III, oxygen also forms ozone (O_3) which surrounds the earth at an altitude of about ten miles and serves as a guard that protects life on the earth--(حفظاً), against the high energy solar radiation.

The Carbon Cycle (Fig. 39). The only source of carbon for the construction of living matter is carbon dioxide of the air.* It enters the living matter through photosynthesis. We noted already, how the carbon chains link up, to form various complex organic compounds. Carbon remains in the body of living organisms in the form of organic compounds till death. After death and decay it returns to the atmosphere in the form of carbon dioxide. This completes one carbon cycle.

*Carbon dioxide is also one of the two sources of oxygen, the other being water.

A portion of carbon in the living body is used as fuel in respiration and is excreted back into the atmosphere as carbon dioxide; where it may be used again in photosynthesis. This forms the second carbon cycle.

Besides restoration of carbon dioxide to atmosphere through biological combustion, it is also restored to it through burning of wood or through burning of coal, oil and natural gas in which it was stored millions of years ago through photosynthesis.

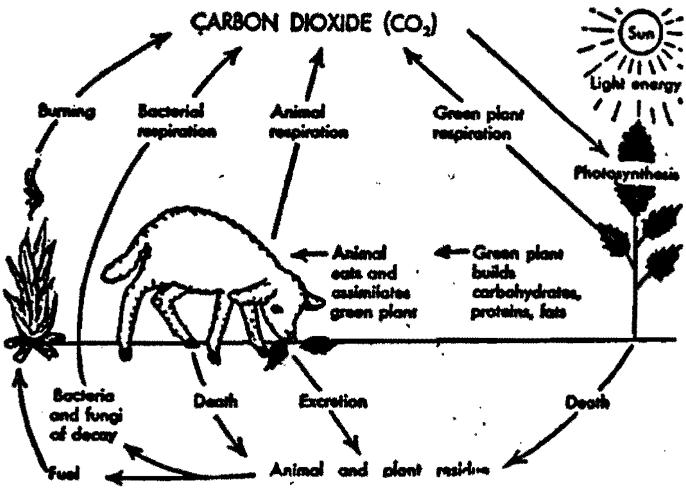


Fig. 39.–THE CARBON CYLCE.

The Nitrogen Cycle (Fig. 40). The nitrogenous compounds of living organisms such as amino acids, nitrogen bases, proteins and nucleic acids, require nitrogen as their raw building material. But the atmospheric nitrogen (N_2) being inert cannot enter into chemical composition. Thus it cannot be utilised directly by majority of organisms. They can, however, utilise nitrate ions (NO_3) which are a common source of usable nitrogen. Plants absorb this ion from the soil and convert it into nitrogenous compounds. As noted already, different kinds of mineral ions from the rocks are washed down by the rivers into the soil, nitrate being one of them. Second source of nitrate ions is the air where atmospheric nitrogen and oxygen are combined by the energy produced by lightning and the nitrates thus produced are carried to the ground by rain. But the quantity of nitrate ions so produced is small.

Animals get the nitrogenous food from the plants. After death and decay of both animals and plants, the organic compounds of nitrogen are converted into ammonia (NH_3).

Bacteria play a very important role for the manufacture of usable nitrogen for the consumption of living organisms. The ammonia is reconverted into nitrates by the

Nitrifying bacteria and the nitrates are again used by the plants as raw material. One type of nitrifying bacteria absorbs ammonia (NH_3) and converts it into nitrite ions (NO_2) which are excreted into the environment. The second type absorbs nitrite (NO_2) and converts it into nitrate (NO_3) which is again excreted. Thus the combined metabolic activities of these two types of bacteria again make available the environmental nitrates.

These nitrates in the environment are acted upon by another set of bacteria called *denitrifying bacteria*. They convert nitrates into molecular nitrogen (N_2) which joins the atmosphere, thus increasing the nitrogen contents of the air and decreasing the nitrate contents of soil and water. But this loss of nitrates is made good by another set of bacteria and blue green algae which live in soil and water.

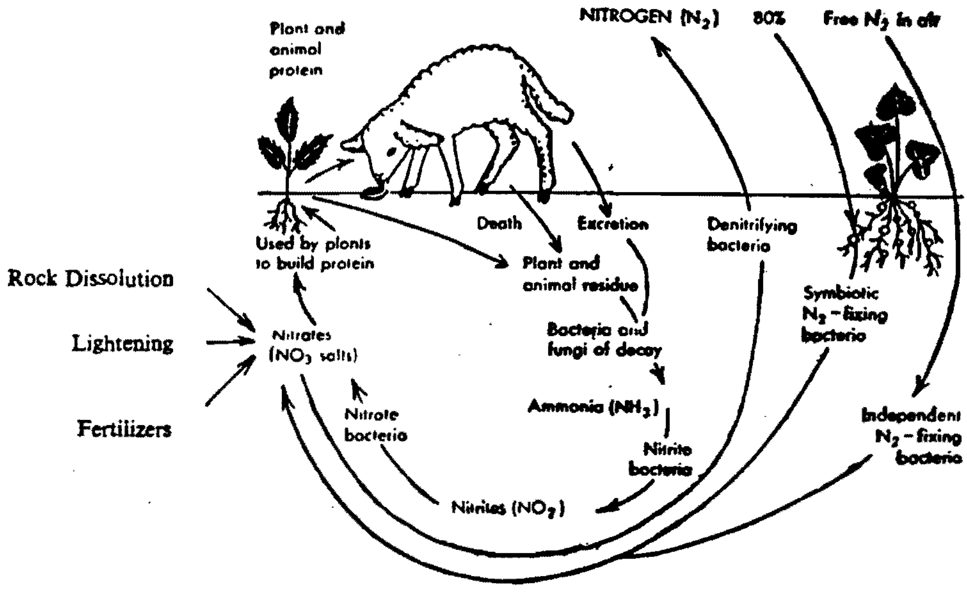


Fig. 40.--THE NITROGEN CYCLE.

These are called *nitrogen fixing organisms*. They are able to utilise the nitrogen in the air directly and convert it into organic nitrogenous compounds. Some of these nitrogen fixers live in the soil as saprotrophs. After death and decay their bodies yield ammonia to the soil which is converted by nitrifiers into nitrate. Another type of nitrogen-fixing bacteria are symbionts* on the roots of plants, such as peas, beans, grams and lentils, where they form root nodules. They fix nitrogen and provide to the

*Symbionts are two different organisms which are attached to each other and work for the mutual benefit. Thus the association is beneficial to both, as opposed to parasitism.

legumes in a usable form. Thus four types of bacteria take part in the completion of this global nitrogen cycle:--

(1) *Decay Causers*. They use dead bodies of plants and animals as their food and excrete ammonia as waste product.

(2) *Nitrifiers*. They use ammonia as a nutrient and excrete nitrites as a waste product. Another set of Nitrifiers use nitrite as nutrient and excrete nitrates as waste products.

(3) *Denitrifiers*. They use nitrates as nutrients and excrete free nitrogen as waste product.

(4) Nitrogen fixers which use free nitrogen as nutrient and excrete nitrates as waste products, to be used by plants.

The above description makes it abundantly clear that living organisms are transient constructions built out of inorganic matter and that the continuity of life depends upon the parallel continuity of death. The Holy Quran expresses it in the following words:

إِنَّ اللّٰهَ فَالِقُ الْحَبِّ وَالنَّوٰى ۖ يُخْرِجُ الْحَيَّ مِنَ الْمَيِّتِ وَمُخْرِجُ الْمَيِّتِ
مِنَ الْحَيِّ ۚ ذٰلِكُمُ اللّٰهُ فَأَنّٰى تُؤْفَكُوْنَ ۝
(6:96)

> "It is the Divine law that causes the seed-grain and the date-stone to split and sprout. It causes the living matter to issue from the non-living and the non-living to issue from the living one. Such is Allah (Whose law reigns supreme in the universe). Then why are you deluded away from the right path?"

CHAPTER X

Self-Perpetuation: The Steady State

(41:10) ...بٰرَكَ فِيهَا وَقَدَّرَ فِيهَآ أَقْوَاتَهَا...*

"He bestowed on it (the earth) SELF-PERPETUATION, and measured therein its means of sustenance".

We have noted already that self-perpetuation includes three principal activities, steady state control, reproduction and adaptation. With steady state controls the living units counteract the destructive and disruptive, physical and chemical forces arising from within and from without. With reproduction the living matter is able to maintain its creative expansiveness in time and space. Adaptation prepares the living units to fight against the forces of environments, after long intervals of time, through successive generations. Thus self-perpetuation makes the living matter on earth potentially indestructible.

The three components of self-pepetuation operate on all levels of living organisation. The maintenance of all higher organisations depends on cellular self-perpetuation. The adaptation depends on reproduction and reproduction depends on steady state controls. Thus the cellular steady state controls form the basis for the maintenance of all higher organisational levels. And as molecular steady state in cells is gene-controlled, genes ultimately form the basis of controls at all levels. Through this, genes also control reproduction and adaptation.

Gene Function. The origin of life took billions of years, as the formation and association of adenosine phosphates, carbohydrates, fats, proteins and nucleotides with water and minerals, was a matter of physical and chemical chance. There was no blue-print to follow. But after the formation of nucleic acids and their association with other ingredients, creation of life was speeded up enormously. Today a bacterium divides and reproduces itself after every 15 minutes and the creation of a new human being takes only nine months. This acceleration in the speed of new creation has been made possible by nucleic acids, or *Genes* the modern descendants of first nucleic acids. Thus the creation, maintenance and control of life today depends on genes.

*For the meaning of the word see (بارک) Glossary (ب ر ك).

Gene Characteristics. As noted already in Fig. 26, the nucleus of a cell consists of a semifluid nucleoplasm or nuclear sap, in which are suspended chromosomes and nucleolus. Chromosomes are filamentous bodies which are made up of nucleoproteins, the proteins being of several types and nucleic acids being DNA (Deoxyribose nucleic acid) and RNA (Ribose nucleic acid). Nobody has ever seen genes but they are known by their works. Physically a gene is not a fixed piece of chromosome. It is some portion of a chromosome which cannot be identified exactly. Chemically however, a gene is a definite entity. It has been clearly established by experiments that genes are composed of DNA which may be regarded as a spiraled double chain, each chain being a nucleotide polymer containing deoxyribose sugars. Two such chains are held together by pairs of purin and pyrimidine components. Four different types of such pairs are present:--*Adenine-Thymin* and the reverse (A.T.--T.A.) and *Guanine-Cytosin* and the reverse (G.C.--C.G.). The four pairs may occur any number of times and in any sequence giving a particular type of DNA its specificity. Functional differences in different types of DNAs are due to these structural differences. Just as certain amino-acid sequences make proteins effective as enzymes, so do certain Purine-Pyrimidine sequences make DNA effective as genes. Thus only a part of the DNA present in a chromosome is genetically active. Each species has a specific number of chromosomes in its nucleus, for example, a human cell contains 46 chromosomes.

The survival of nucleus and cytoplasm are interdependent. The genes in a nucleus control the activities of cytoplasm, the cytoplasm on the other hand feeds the nucleus.

The Genetic Code. Genes, as we know, are nucleic acids: thus depending on their nucleotide sequence genes provide specific information by way of a chemical code. This information is carried by other information carriers. It is in the form of building instructions for two kinds of jobs (1) For the reproduction of genes resulting in the formation of exact copies of the original ones (2) For protein synthesis from amino acids. Every time a cell divides, new genes are formed inside the cell nucleus. Thus before division, a cell contains two exactly similar gene sets. One set is transferred to each of the two newly formed cells. This is how the information code is carried through successive cell generations.

Ribosome granules (Fig. 26) are the seat of protein synthesis. Ribose nucleic acid RNA is located at three sites within a cell, in Ribosomes, in nucleoli and in chromosomes. RNA is chemically similar to DNA. DNA serves as a template for RNA while under construction in Chromosomes. The RNA nolecules then accumulate in nucleoli from where they are carried to ribosomes. Here they function as templates in their own turn and instruct the synthesis of specific proteins. DNA thus exercises its control over the production of specific proteins through the medium of RNA.

Genes are not only agents of heredity but they control functions during the entire life of a cell or an organism. All multicellular organisms during reproduction have got to pass through the stage of a single cell (نفس واحدة). Thus one whole cell with all its parts is passed on from one generation to the other. Consequently the gene-control of the entire range of cellular functions passes through successive generations.

We noted already that proteins form the organic framework of cells and that any other constituents like fats, carbohydrates and minerals etc. get secondarily deposited within this framework. Protein synthesis being gene-controlled, the architecture of every cell is thus gene-controlled. Any normal change in the architecture of a cell during its life time and every architectural difference between the cells of one or of different organisms is ultimately gene determined.

All enzymes are proteins and are thus gene determined. Every metabolic function in a cell requires at least one enzyme. Thus all metabolic functions are gene-controlled, whether they are involved in respiration, nutrition, locomotion or any other process.

Besides, genes control all other control agents within a cell. They regulate the action of vitamins by controlling their manufacture within cells and again by regulating surface absorption in cells which do not produce their own vitamins. They also control the surface absorption of water and minerals. They regulate hormone action by determining which cells are to synthesize which hormones and also by determining which hormones and in what quantities are to be allowed to pass through the plasma membrane of each cell. Thus whereas vitamins, enzymes, minerals and all other growth factors control metabolic processes directly, genes control them indirectly.

As genes govern synthesis in general and production of new genes in particular, the growth, development and reproduction of cells also became gene-controlled. Genes form basis of sex, either by being exchanged among cells or by being pooled within cells(ثم جعل منها زوجها). By duplication and transmission through successive cell generations, genes formed the basis of heredity. By mutation genes became the key to evolution.

CONTROL AGENTS OF ORGANISMS

As noted above, genes are the controllers of all other control agents in an organism. These control agents form part of the control systems which maintain steady state at various levels of living organisation. The normal smooth working of a system may be upset by various internal and external factors which we call stresses. External stress may be innumerable physical, chemical and biological conditions, such as scarcity of food and water, change of temperature, various kinds of enemies and injurious agents etc. Internal stress continuously arises from the very processes of life. There is normal wear and tear of parts, fuel foods are used up, waste products accumulate, concentrations change etc. An organism is in fact constantly under stress. The necessary requirement is that it should be able to recognise where and when a stimulus arises. As long as it is able to recognise it and react to it in an appropriate manner, it shall go on functioning smoothly despite stress. Thus the life span of an organism depends on how long it is able to counteract various stresses and maintain steady state. A control system in which many parts act in cooperation with one another, steady state shall be maintained only if the co-operating parts work smoothly despite stress; and if functions of one part are disturbed, the other parts compensate in such a way that the total co-ordinated working of the entire system remains undisturbed.

It is outside the scope of this work to describe in detail the various controls that work in the bodies of organisms, but the following paragraphs shall make it clear, how this co-operation is carried out. We take, for example the, working of Hormones.

HORMONES

The synthesis of genes and enzymes takes place directly inside the cells in which they exert controlling influence. There are other intra-cellular controllers which may originate outside the cells in which they function. As these imported controllers influence the growth and development of cells, they are called *Growth Factors*. Depending on their sources, these growth factors are placed in two general categories. If the source is external environments they are called *Growth Regulators*; for example, vitamins and minerals. Vitamins come under the category of growth regulators only in the case of animals, as all plants produce their own vitamins. On the other hand, if a controller is produced in a certain body part of an organism and is transported to such other cells within the body of the same organism which cannot manufacture it, then that growth factor is called Hormone.

The most advanced groups of animals, i.e., insects and vertebrates possess specialised endocrine glands. The secretions of certain glands which are drained by means of ducts are called External Secretions, as for example, milk, saliva, spermatic fluid etc. The hormones on the other hand are not drained by means of ducts but are directly absorbed into the blood. Therefore they are called Internal Secretions.

The hormones vary in chemical composition. All cells of an organism require all hormones produced in its body. Hormones not only control cellular processes, they also control the manufacture and secretion of one another. The output of each gland is controlled wholly or partially by the output of one or more other glands. As a result, the overall output of all glands is carefully balanced. A given cellular process is accelerated by one hormone and inhibited by another. Therefore there is a continuous readjustment of hormone secretions relative to one another and relative to the requirements of a particular moment. This makes possible an overall flexible control over the various cellular processes. The maintenance of this chemical regulation among the various parts of an organism is made possible by the facilities for distribution afforded by the circulatory system and also by the nervous system which provides a central station with facilities for instantaneous communication between all parts of the body.

A brief description of endocrine glands in the human body shall illustrate this flexible control system.

Pituitary Gland. It is situated in a small fossa in the base of skull, underneath the brain. It consists of three parts, the anterior lobe, the intermediate lobe and the posterior lobe. Each of these is a complete, functionally distinct gland, secreting its own hormones.

The Anterior Lobe. It secretes tropic hormones which exert a specific influence on the production and secretion of certain other hormones. These tropic hormones are as follows:--

Thyrotropic hormone (TTH) which controls the secretion of Thyroid hormone or Thyroxin.

Gonadotropic hormones (GTH) which control the secretion of sex glands, ovaries and testes.

Adrenocorticotropic hormone (ACTH) which controls the secretion of cortex (outer layer) of the adrenal gland.

The control of anterior pituitary hormones over other endocrine glands is not a one way act; but they themselves are governed by the very glands they stimulate. This illustrates the mutual checking up process described above which balances the output of various endocrine glands. For example, as more and more TTH is secreted by the anterior pituitary, more and more thyroxin will be secreted by the Thyroid gland. But once the concentration of thyroxin has reached a certain level in the blood, it exerts an inhibitory effect on TTH secretion. This in turn further reduces or stops the production of thyroxin. Conversely if the blood concentration of thyroxin is low, the anterior pituitary shall excrete more TTH. The Thyroid gland will therefore be stimulated more strongly and more thyroxin will be produced. Thus the two glands form an automatic organ-level control system.

In addition to producing tropic hormones, the anterior pituitary also manufactures other hormones which act as metabolic regulators. In this category is *Prolectin*, or lactogenic hormone which participates in the control of milk production in mammals. It initiates and maintains lactation after the mammary glands have matured under the influence of other hormones. Increase of prolectin in blood increases milk production and deficiency reduces it.

Regarding the phenomenon of milk production the Holy Quran says:

وَإِنَّ لَكُمْ فِي الْأَنْعَامِ لَعِبْرَةً نُّسْقِيكُم مِّمَّا فِي بُطُونِهِ مِن بَيْنِ
(16:66) فَرْثٍ وَدَمٍ لَّبَنًا خَالِصًا سَائِغًا لِّلشَّارِبِينَ

> "And verily in the cattle you will find an instructive sign. We give you to drink from that which is in their bellies, something in between the excretions and the blood, pure milk palatable to the drinkers".

The word فرث in the above verse has not been correctly interpreted by most of our commentators. Some have translated it as 'refuse (or faeces)', others as 'masticated food (or gastric contents)'. Actually it means neither gastric nor intestinal contents. The word بين 'in between', makes it clear. فرث means anything that has been broken up into minute particles (Ibn-e-Faras). Accordingly in the above verse it means 'excretions'. The mammalian body produces out of blood, secretions as well excretions. Secretions are the useful products which serve one purpose or the other, inside or outside the body of the animal. For example, saliva or gastric juice are secretions, their function being to digest food. Similarly milk is a secretion, which serves as a food for the offspring. Again spermatic fluid is a secretion which carries male germ cells for union with the female germ cells. On the other hand excretions are waste products which being no more useful to a living organism are returned to the non-living world. Examples are urine, perspiration, carbon dioxide etc. A secretion, such as milk, is neither blood nor excretion but a substance in between the two. It is no more useful to the body that produces it but still it is not a waste product.

Another anterior lobe secretion is a Growth Hormone. In the young, this hormone maintains growth rates of cells generally. Excessive secretion of this hormone leads to Gigantism and deficiency results in Dwarfism. The anterior lobe also controls carbohydrate, protein and fat metabolism directly or indirectly via tropic hormones.

The Intermediate Lobe. This secretes Intermedine which regulates the behaviour of chromatophores (pigment cells) in the skin of certain vertebrates such as frog. The skin colour of frog is adjustable. The colour becomes dark when the pigment granules in the chromatophores are spread out and cover other elements in the skin. It becomes pale when the granules are concentrated. Intermedine brings about the expansion of chromatophores and the consequent dispersal of pigment granules. In the absence of chromatophores, the hormone is without function.

The Posterior Lobe. It secretes several hormones. Some regulate the excretion of water which function is also performed by Adrenal hormones. Deficiency of these hormones is characterised by the passage of large quantities of urine of low specific gravity. Other hormones of posterior pituitary stimulate the contraction of smooth muscles particularly those in the walls of Blood Vessels and Uterus. Thus through its control over the size of lumen of blood vessels and over water excretion, the posterior pituitary influences Blood Pressure.

Thyroid Gland. It lies over the front side of neck, on either side of trachea (windpipe), joined by an Isthmus. It secretes thyroxin, accelerates respiration in the cells and thus controls general metabolism. It also controls development processes. We noted already that it influences and is influenced by TTH (Anterior Pituitary Hormone).

Parathyroid Glands. These are two small glands which lie embedded in the substance of thyroid gland on either side. They control calcium metabolism in cells and thus maintain a constant calcium level in blood.

Adrenal Gland. There is one adrenal gland situated in close proximity to each of the two kidneys. The gland has two distinct parts, a peripheral part called Cortex and a central part called Medulla.

The Adrenal Cortex. It produces more than 100 different compounds, cortisone being one of them. Cortical hormones control the metabolic processes within cells involving particularly water, minerals and carbohydrates. They also control the secretion of sex hormones and are in turn influenced by them.

The Adrenal Medulla. It produces adrenaline which acts as a chemical whip which makes various organs respond quickly in the general mobilisation of the body. It is secreted during danger or emergency when an animal is under great physical and emotional stress. Thus it increases heart rate. It raises blood pressure by contracting arterioles. It stimulates the liver to release its stored glycogen which gets converted into blood sugar (glucose) promoting an increase in muscular power and resistance to fatigue. It retards the activities of the alimentary canal. It stimulates the tiny muscles attached to hairs or feathers. It dilates the pupils of the eye. It promotes faster coagulation of blood. It generally promotes faster and sharper responses to stimula. Together these reactions are called Alarm Reactions. If adrenaline is not released into the blood in an adequate amount, an animal shall not be able to adjust rapidly to emergency.

Sex Glands. In male, testes are the primary sex organs. The sperm ducts with associated glands and penis are accessory sex organs. Testes together with the accessories form the Male Genital System. In female, ovaries are the primary sex organs; and oviducts, uterus and vagina are accessory sex organs. Ovaries and accessories together form the Female Genital System.

As already noted, sex hormones are produced in matured ovaries and testes under the stimulus of GTH (gonadotropic hormone of Anterior Pituitary). Several male and female sex hormones are manufactured. The male hormones collectively are called Androgens and the female hormones as Estrogens. Firstly, these hormones maintain the primary sex characteristics, i.e., the structural and functional integrity of the male and female reproductive systems. This includes the uterine changes and the menstrual cycle in female. Secondly, they maintain socondary sex characteristics, i.e., all features other than sex organs which differentiate male from the female. Such secondary male female differences include different patterns of growth and of hair distribution; differences in voice; differences in physical strength, endurance and muscular development; skeletal differences, as in the hip region; differences in the amount of fat under the skin; marked differences in the degree of mammary developoment and differences in skin colouration and plumage among fish, birds and other vertebrates. In addition sex hormones maintain sex urge; they influence mental vigour and mental development and stimulate blood circulation etc.

Pancreas. It is a flattened, elongated organ, lying behind the stomach. It manufactures two types of secretions. One is Pancreatic juice which is carried by means of a duct into the intestinal canal where it promotes digestion. The second known as Insulin is an internal secretion and is poured directly into the blood stream.

In the digestive process sugars, starches and some fats and proteins are turned into glucose which is consumed as fuel by the body cells. Before glucose can enter the metabolic machinery of the cell, it must first be phosphorylated by ATP in the presence of enzyme hexokinase to form glucose-6-phosphate. Subsequently the hexose is either built up into glucogen or dissimilated. In the absence of insulin the initial phosphorylation reaction does not proceed at the normal rate. Insulin promotes the reaction while the anterior pituitary and adrenal cortex hormones block it. In the normal animal the actions of insulin and its antagonists are correctly balanced. An excess or deficit of either group of hormones disturbs the rate at which the phosphorylation of glucose proceeds. Thus lack of insulin decreases the rate of glucose uptake by the cells, excess of insulin has the reverse effect. Excess of anterior pituitary or adrenal cortex hormones has the same effect as lack of insulin. It is probable that these hormones act on the complex enzyme systems which control the reaction.

There are various other hormones, such as Gastrin produced in the stomach, and Renin produced in the kidneys.

The steady state regulation gets more and more complex from lower to higher animal groups and is achieved not only by cellular growth factors such as hormones and vitamins described above but also by numerous tissue and organ-level control systems which do not have counterparts in plants.

Human Aspect. There is such a close functional co-operation among various parts in the commonwealth of the body that it gives food for thought not only to the biologist but also to the sociologist. We have noted that the steady-state of any organisation is universally based on the united integrated function of its component parts. The case is not different with human social organisation. There is one God

Whose law operates throughout the universe, in the physical world as well as the human world. Human body is controlled by the physical and the chemical laws; and the human *Self* or *Personality* is controlled by the revealed laws which have been given to mankind through messengers of Allah who appeared on the earth in different ages. Their message was one and that was unity of action and harmony in human society. The way of life prescribed by Allah is one for the whole of mankind. It ensures the development and steady state of human society and serves as a guard against stress and disintegration. Every time a messenger of Allah came, he brought the same universal truth, explained in the manner understandable by the people of his age. But after a lapse of time the human self-interests made his followers deviate from the path shown by him, until another messenger came with basically the same message. This continued until man was mature enough to receive a complete code of life applicable for all times to come. This final code was brought by the last messenger of Allah, Muhammad (peace be upon him). Had mankind stuck to the essence of message from the Sustainer of the universe, they coud not differ from one another. Differences arose because they followed laws other than those of Allah and forsook the universal truth. They fell into schisms, envy and hatred amongst themselves.

The Holy Quran says:

شَرَعَ لَكُمْ مِّنَ الدِّيْنِ مَا وَصّٰى بِهٖ نُوْحًا وَّالَّذِيْٓ اَوْحَيْنَآ اِلَيْكَ وَمَا وَصَّيْنَا بِهٖٓ
اِبْرٰهِيْمَ وَمُوْسٰى وَعِيْسٰٓى اَنْ اَقِيْمُوا الدِّيْنَ وَلَا تَتَفَرَّقُوْا فِيْهِ كَبُرَ عَلَى الْمُشْرِكِيْنَ
مَا تَدْعُوْهُمْ اِلَيْهِ اَللّٰهُ يَجْتَبِيْٓ اِلَيْهِ مَنْ يَّشَآءُ وَيَهْدِيْٓ اِلَيْهِ مَنْ يُّنِيْبُ ۝ وَمَا
تَفَرَّقُوْٓا اِلَّا مِنْۢ بَعْدِ مَا جَآءَهُمُ الْعِلْمُ بَغْيًۢا بَيْنَهُمْ وَلَوْلَا كَلِمَةٌ سَبَقَتْ مِنْ
رَّبِّكَ اِلٰٓى اَجَلٍ مُّسَمًّى لَّقُضِيَ بَيْنَهُمْ وَاِنَّ الَّذِيْنَ اُوْرِثُوا الْكِتٰبَ مِنْۢ
بَعْدِهِمْ لَفِيْ شَكٍّ مِّنْهُ مُرِيْبٍ ۝

(42:13-14)

"The same way of life has been ordained for you as that which He enjoined on Noah and that which We have revealed to you (O Muhammad) and that which We had commanded to Abraham, Moses and Jesus, enjoining that you should steadfastly establish the social order (based on His guidance) and make no division therein. Disconcerting is (the way) to which you call to those who follow laws other than the divine laws. (They object to Muhammad, peace be upon him, being chosen as a messenger of Allah. Say) Allah chooses for this purpose whom He considers fit according to His Divine law and guides to the right path whosoever turns towards Him. And they became divided after the knowledge reached them, through mutual rivalry. Had it not been already laid down by Allah that they would be given respite for an appointed term, the matter would surely have been settled between them long ago (i.e., there is a period between an action and the outcome of its result). As for those who have inherited the book after them they have grave doubts about it. (If they had thought over the Quran with an open mind, all differences would have disappeared. But their prejudice, self-interests and envy made them suspicious about this book)".

Again it is said:

وَاعْتَصِمُوا بِحَبْلِ اللّٰهِ جَمِيعًا وَّلَا تَفَرَّقُوا ...

(3:102)

"(Oh you who believe!) Hold fast, all of you together, to the cable of Allah (i.e.,the way of life Allah has prescribed for you) and be not divided amongst yourselves."

Again it is said:

إِنَّ الَّذِينَ فَرَّقُوا دِينَهُمْ وَكَانُوا شِيَعًا لَّسْتَ مِنْهُمْ فِي شَيْءٍ إِنَّمَا
أَمْرُهُمْ إِلَى اللّٰهِ ثُمَّ يُنَبِّئُهُمْ بِمَا كَانُوا يَفْعَلُونَ ○

(6:160)

"Those who create differences in *Deen*(i.e. the way of life prescribed by Allah) and divide themselves into sects (O Messenger of Allah!) you have nothing to do with them. Leave their affair for the law of Allah to decide. That will tell them how they acted."

Again it is said:

فَتَقَطَّعُوا أَمْرَهُمْ بَيْنَهُمْ زُبُرًا كُلُّ حِزْبٍ بِمَا لَدَيْهِمْ
فَرِحُونَ ○ فَذَرْهُمْ فِي غَمْرَتِهِمْ حَتّٰى حِينٍ ○

(23:53-54)

"But rather than preserve their unity, people split themselves into factions. Each group rejoices in what it adheres to. You had better leave them in ignorance for a while."

Again it is said:

مُنِيبِينَ إِلَيْهِ وَاتَّقُوهُ وَأَقِيمُوا الصَّلٰوةَ وَلَا تَكُونُوا مِنَ الْمُشْرِكِينَ ○ مِنَ الَّذِينَ
فَرَّقُوا دِينَهُمْ وَكَانُوا شِيَعًا كُلُّ حِزْبٍ بِمَا لَدَيْهِمْ فَرِحُونَ ○

(30:31-32)

"Turn unto Him (and Him alone) and be afraid (of the consequences of turning away from His laws); establish Salat(i.e., the social order based on His guidance) and be not among those who follow laws other than His and thus set up peers to Allah, (i.e.) be not of those who create cleavage in their social order and resolve

> themselves into various sects where each sect is obsessed with its own view of it.

Again it is said:

وَآتَيْنَاهُم بَيِّنَاتٍ مِّنَ الْأَمْرِ فَمَا اخْتَلَفُوا إِلَّا مِن بَعْدِ مَا جَاءَهُمُ الْعِلْمُ
بَغْيًا بَيْنَهُمْ إِنَّ رَبَّكَ يَقْضِي بَيْنَهُمْ يَوْمَ الْقِيَامَةِ فِيمَا كَانُوا فِيهِ يَخْتَلِفُونَ (45:17)

> "And We gave them a clear code of life. It was only after the knowledge had come to them that they fell into schisms through mutual envy. Verily thy Rabb will judge between them on the Day of Judgment in respect of that in which they differed."

The hurdles in the way of unity of mankind can be removed only by following the code of life revealed by the Creator of the universe, which ensures the security and development of the human society. This code of life today lies safely preserved in the Holy Quran. We shall deal with the fundamental principles of the Quran in the last chapter of this book.

CHAPTER XI

Self-Perpetuation: Reproduction

PATTERN OF REPRODUCTION

وَاللَّهُ خَلَقَكُم مِّن تُرَابٍ ثُمَّ مِن نُّطْفَةٍ ثُمَّ جَعَلَكُمْ أَزْوَاجًا ... (35:11)

"And Allah created you from inorganic matter, then from a little fluid (a reproductive unit without sex), then He made you in pairs (sexual reproduction)."

The expansion of living matter through time and space takes place by means of Reproduction. The reproduction at a higher organisational level requires reproduction of all the lower units. The reproduction of a tissue depends on the formation of new cells, the reproduction of a cell depends on the formation of new molecules from the raw materials. Molecular reproduction therefore forms the basis of reproduction at all higher levels.

The cells draw water, mineral ions or molecules from the environments. The enzymes which are proteins, synthesize carbohydrates and fats. Nlucleic acids link up proteins from amino acids and also reproduce themselves to form new nucleic acids. How fast the new molecules are synthesized inside the cell depends on the supply of nutrients. If the wear and tear is faster than the molecular reproduction, the growth and reproduction of the cell is obstructed.

With molecular synthesis a cell grows and having attained a certain size, it reproduces itself by dividing into two essentially equal parts. Cell division is one of the most important biological events. *Reproduction of an organism is basically cell division*, though in higher forms of life it is largely obscured by the accompanying phenomena. Cell division causes unicellular organisms to multiply. In multicellular organisms, the parts worn out or destroyed by injury are replaced by regeneration and healing respectively. Reproduction also adds new units to old ones and produces multicellular adults by the creation of reproductive cells or gametes.

REPRODUCTION OF CELLS

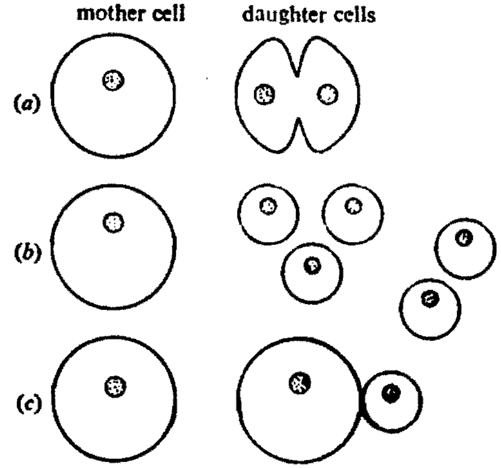


Fig. 41.—Types of CELLULAR REPRODUCTION.
(a) binary fission. (b) multiple fission. (c) budding.

In lowest forms of life such as bacteria and blue greens, a mother cell may divide into a number of daughter cells. This is called *Multiple Fission*. But in all other plants and animals, division of a cell into two equal parts, called *Binary Fission*, is the rule. There is a third category in which the cell divides into two unequal parts. This is called *Budding* (Fig.41).

In binary fission, the cytoplasm and nucleus both divide simultaneously. The number of chromosomes is doubled, two sets of exactly equal number being formed, one set gets incorporated in one daughter nucleus and the other into the second daughter nucleus. This form of duplication is known as Mitosis.

Mitotic Cell Division (Fig.42a). The process involves four different stages:-

1. *Prophase.* A cell usually contains two centrioles. If there is one it divides. Each of the two centrioles move towards the opposite sides of nucleus. Around each centriole fine short radiating fibres appear in the cytoplasm to form an *Aster* and other longer fibres extend in flat curves between the separating centrioles and form a *Spindle*. The line joining the two centrioles is called *Spindle Axis*. Simultaneously the nuclear membrane dissolves and the chromatin within nucleus becomes evident as distinct chromosomes. Each chromosome is composed of two wavy parallel filaments, the chromatids (Fig.42b). The chromatids are joined to each other at a single point called centromere. The two spindle fibres from either side get attached to the chromatids at the centromere.

2. *Metaphase.* During this phase of mitosis the duplicated (split) chromosomes become located in the equatorial plate of the spindle which is a plane situated at right angles to the spindle axis, midway along it; specifically it is the centromere of each chromosome which comes to lie in this plan (Fig.42c).

3. *Anaphase.* The daughter halves of the duplicated chromosomes now move to the opposite poles of the spindle due to the contraction of spindle fibres.

4. *Telophase.* The daughter nuclei are now reconstructed. The chromosomes return to the state in which they existed before mitosis began. A nuclear membrane appears and the spindle fibres disappear, the gel composing them being reconverted into a solid state. The cell body divides into two by a constriction which arises as a furrow at right angle to the spindle. The processes involved in the formation of newly formed nuclei and the cleavage of cytoplasm take place simultaneously.

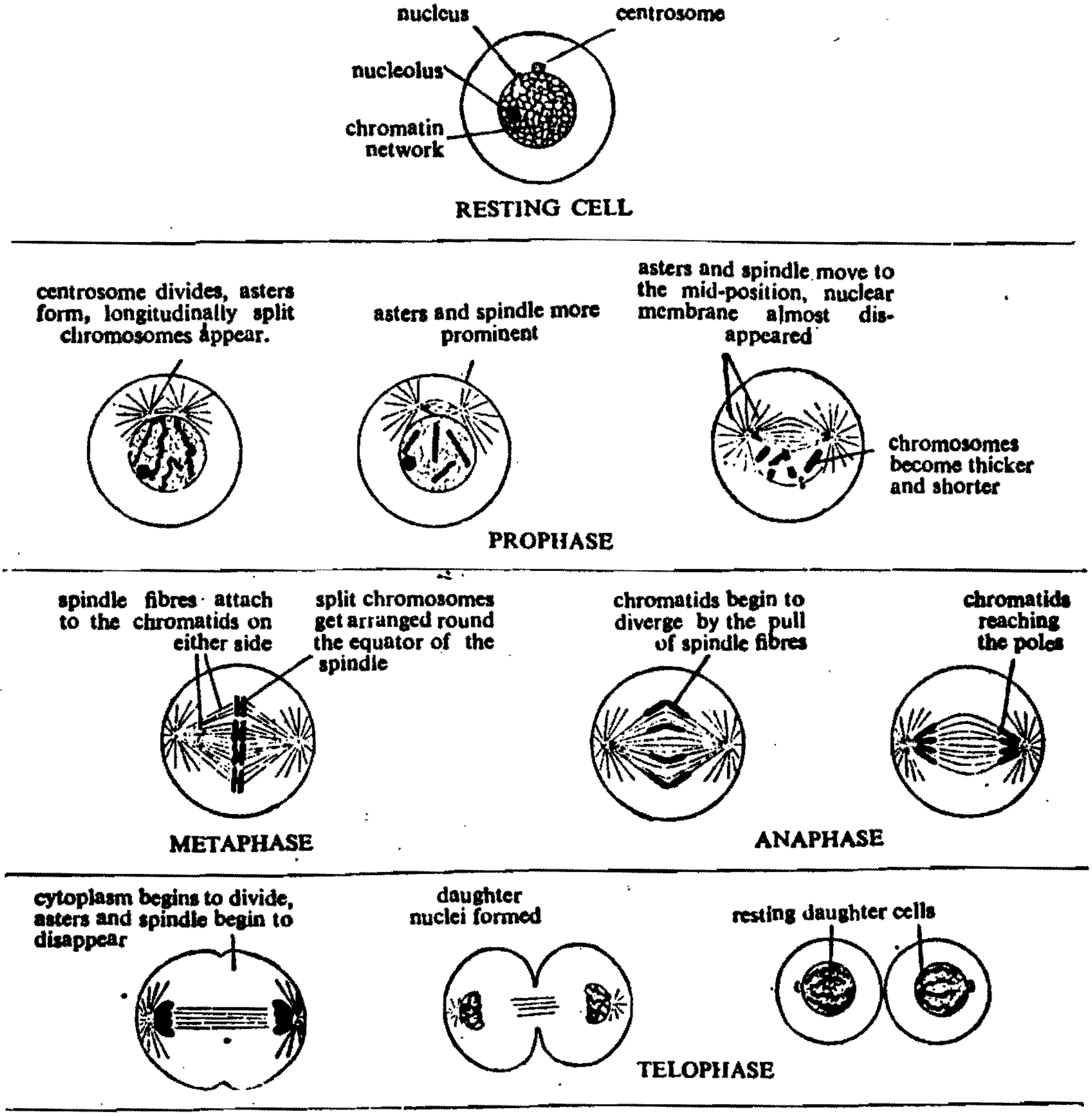


Fig. 42a.—MITOSIS.

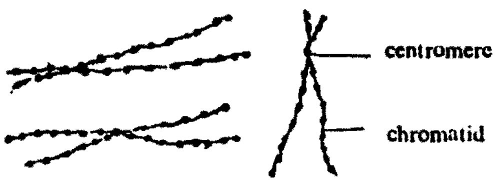


Fig. 42b.—The daughter chromosomes or chromatids united at the centromere. Location of centromere varies with different chromosome pairs.

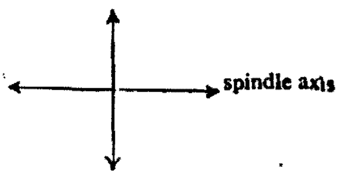


Fig. 42c.—The plain occupied by the centromeres is at right angle to the spindle axis during metaphase.

REPRODUCTION OF ORGANISMS

The reproduction of a unicellular organism consists of the reproduction of molecules and the division of cell. The reproduction of a multicellular organism, on the other hand, takes place in two distinct phases-(1) First the separation of reproductive unit from the parent organism. (2) Second, the development of the separated reproductive unit into a new organism.

An organism reproduces itself either Asexually or Sexually.

Asexual Reproduction. This occurs when new individuals are reproduced from the parent, without any reproductive structures. It occurs in many plants and lower animals. For example, protozoa such as Paramecium which multiply by binary fission. The entire cell is a reproductive unit in this case.

In some organisms asexual reproduction may occur after injury to the parent by external agents. For example, in some flat worms and ribbon worms, an individual may fragment itself into two or more parts, each capable of growing into a complete animal. Here a part of the organism forms the reproductive unit. This is also known as Vegetative Reproduction.

Sexual Reproduction. It is a universal case that the smallest unit which contains the gametic information and complete apparatus for the production of a new multicellular organism is a single cell which the Holy Quran calls نفسٍ واحدة. There are two general types of these reproductive cells:-

(1) One class includes cells which divide by multiple fission and each daughter cell develops directly into an adult. Such cells are called spores and are common in plants. This type of reproduction is called *Sporulative*.

(2) Another class of reproductive cells are those which cannot develop directly into new adults. They must first undergo a sexual process in which two cells join to create a new individual. Such sex cells are called *Gametes*. Their fusion is called Fertilisation and the resultant fused cell is called a *Zygote*. Thus here the reproductive process occurs in two phases:-(a) Formation of reproductive cells or gametes (b) Fertilisation of female gamete by male gamete and the development of the resultant zygote into an adult. Here the complete reproductive unit is zygote (نفسٍ واحدة).

As described above a reproductive unit may arise direct from a single organism or it may arise by the union of gametes from two different individuals, male and female. This phenomenon has been described by the Holy Quran in relation to the human evolution in the following words:

وَاللّٰهُ خَلَقَكُمْ مِّنْ تُرَابٍ ثُمَّ مِنْ نُّطْفَةٍ ثُمَّ جَعَلَكُمْ اَزْوَاجًا ... (35:11)

> "Allah created you from inorganic matter, then from a 'little fluid' (a reproductive unit without sex), then He made you in pairs (sexual reproduction)."

Each one of the three types of reproduction, vegetative, sporulative and gametic, has got an adaptive advantage. In vegetative reproduction the organisms can reproduce at a great speed. This is particularly common in unicellular organisms. A huge number is produced in a very short time. For example, a bacterium divides after every 15 minutes and an amoeba divides by mitosis in 33 minutes at a temperature of 24°C.

Spore formation is found in organisms which cannot disperse by locomotion. Thus sporulation is a device for dispersal of organisms in far and wide areas. In water a spore cell may swim by means of flagella and thus move long distances away from the parent organism. On land spores are encapsulated so that they are prevented from drying up and they are carried to far off territories by wind and animals.

Gametic reproduction has got certain disadvantages. As the meeting of two gametes depends on chance, a large number of them get wasted. Secondly a male gamete has got to move from one place to the other to find a mate, because a female gamete in all cases and parent organisms in some cases are not capable of moving. Also a water medium is required for fertilisation, which may or may not be available. But all these disadvantages are minor as compared with one major advantage and that advantage is sex.

Significance of sex. Sex and reproduction may or may not occur together. This is apparent in those organisms in which the processes of sex and reproduction are distinctly separate. Filamentous green algae which form dense growth in fresh-water ponds are an example (Fig. 43a). The green algae may be considered to be at the border line between the asexual and sexual types of plants and accordingly have been intensively studied. Throughout the spring, summer and early fall, the cells of filamentous green algae reproduce vegetatively. They add to the length of the filament by mitotic division. Pieces may break off and settle at different places and grow into new individuals. Later in fall, two cells from two diferent filaments lying side by side may change materials through an inter-connecting bridge. The contents of one cell then pass into the other. The two cells thus fuse to form a zygote which secrete a wall around itself and forms a cyst. In the following winter all non-conjugated cells die but the cyst survives. In the following spring when the ice melts and temperature rises, the cyst wall breaks open and the zygote gives rise to a new filament.

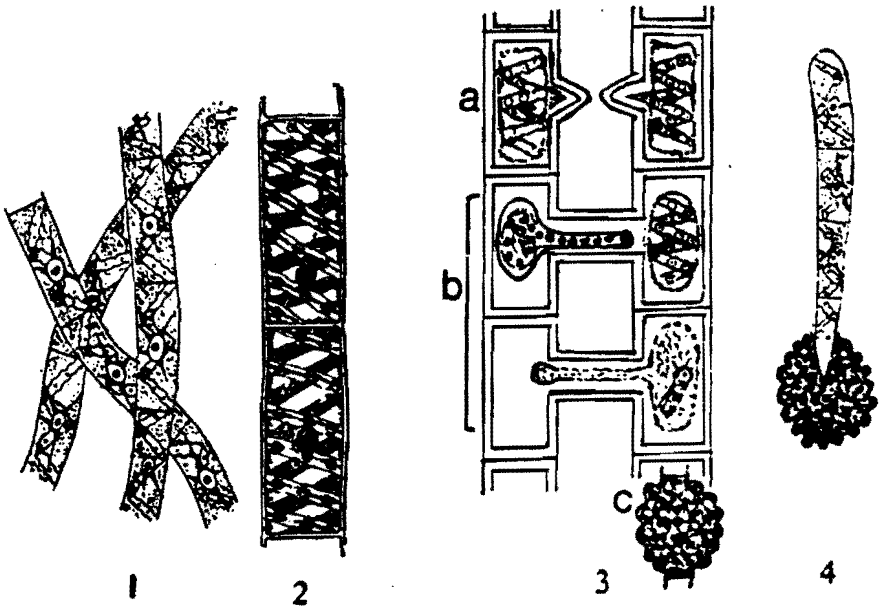


Fig. 43a.--SEXUALITY IN GREEN ALGAE.
(1) colony cells, (2) cells magnified.
(3) two conjugating filaments lying side by side.
(a) bridge between opposite cells.
(b) migration of contents from one cell to the opposite cell
(c) formation of cyst or zygospore.
(4) growth of new filament from the (cyst).

A similar process occurs in paramecium where the two cells do not fuse together but exchange nuclear materials and gene sets (Fig. 43b).

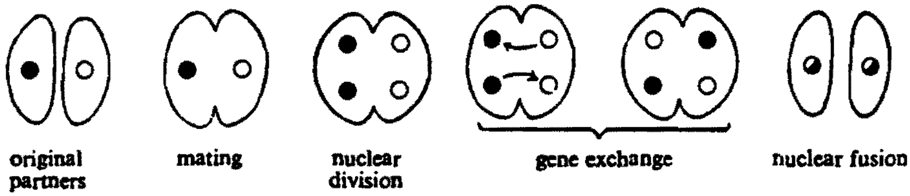


Fig. 43b.--SEXUALITY IN PARAMECIUM.
(exchange of nuclear material)

The above two examples make it abundantly clear that the process of sex and reproduction are two seaprate things though in most cases they occur together. Sexual activity is a protective mechanism to meet the stress of environments and occurs under those conditions which cannot be quickly responded to through steady state control and reporduction. Such conditions may be unfavourable climates as shown above in the case of green algae and paramecium; or they may be food shortage or over-population etc. Every zygote possesses the genes of two gametes which are cells not related to each other. The two different gene sets together are better able to cope with the stress of environments than either of the two gametes on account of the increase in their potentialities for survival.

The Holy Quran mentions sex formation in the following words:

وَهُوَ الَّذِي مَدَّ الْأَرْضَ وَجَعَلَ فِيهَا رَوَاسِيَ وَأَنْهَارًا وَمِن
(13:3) كُلِّ الثَّمَرَاتِ جَعَلَ فِيهَا زَوْجَيْنِ اثْنَيْنِ ...

"It is He Who spread out th earth (in spite of its being round) and made therein mountains and streams; and of all fruits, He placed therein *two opposite sexes*".

(31:10) ... وَأَنزَلْنَا مِنَ السَّمَاءِ مَاءً فَأَنبَتْنَا فِيهَا مِن كُلِّ زَوْجٍ كَرِيمٍ ۝

"We send down rain from above and produce in it (the earth) every kind of profitable growth *in pairs*".

أَوَلَمْ يَرَوْا إِلَى الْأَرْضِ كَمْ أَنبَتْنَا فِيهَا مِن كُلِّ زَوْجٍ كَرِيمٍ ۝ إِنَّ فِي
(26:7-8) ذَٰلِكَ لَآيَةً وَمَا كَانَ أَكْثَرُهُم مُّؤْمِنِينَ ۝

"Have they not seen in the earth, how many of every fruitful *pairs* We make to grow therein? Here indeed is a sign, yet most of them are not believers".

سُبْحَانَ الَّذِي خَلَقَ الْأَزْوَاجَ كُلَّهَا مِمَّا تُنبِتُ الْأَرْضُ
(36:36) وَمِنْ أَنفُسِهِمْ وَمِمَّا لَا يَعْلَمُونَ ۝

"Glory to him Who created *pairs* (opposite sexes) of all things that grow from the earth and of human beings and things of which they have no knowledge".

Note that nothing but revelation could proclaim to the world 1400 *years ago that sex occurs not only in man and other animals but also in plants that grow from the earth; not only in creatures known to man but also in objects not yet discovered by him.*

The word زوج used in the Holy Quran, means a pair of living objects complementary to each other, so that one remains incomplete without the other. Taking it further, it might also mean any pair of complementary objects other than living ones. The following verse of the Holy Quran may be considred in support of this view:

(51:49) وَمِنْ كُلِّ شَيْءٍ خَلَقْنَا زَوْجَيْنِ لَعَلَّكُمْ تَذَكَّرُونَ ○

"And everything We have created in pairs, that you may receive instruction".

The above refers not only to pairs amongst the plants and animals but everything living and non-living. This verse needs detailed comments. However, briefly speaking, when one atom or ion reacts with the other, to form a compound, they both become زوج of each other. For example $C + O_2 = CO_2$. Here carbon and oxygen become each others

'MOWADDAT' * (Mutual attraction)

The Holy Quran says:-

إِنَّهُ هُوَ يُبْدِئُ وَيُعِيدُ ○ وَهُوَ الْغَفُورُ الْوَدُودُ ○ ذُو الْعَرْشِ الْمَجِيدُ ○ (85:13-15)

"He it is Who initiates creation and then gives it turn time after time (to bring it gradually to a final shape). He is الغفور the protector against the forces of disintegration and الودود the bestower of mutual attraction between objects and the One Who has control over the entire universe".

The protection against the forces of destruction and mutual attraction between a pair of objects which the Quran calls مودّت form the basis of evolution. The mutual attraction between a pair of objects is present at all levels of existence, from subatomic particles to higher animals and man. The attraction is in the form of pair bonds and the pair is termed زوجين. As stated above, the pair may be living or nonliving and each individual of a pair is complementary to each other, one remaining incomplete without the other. As stated earlier the positive and negative charges in a pair of two different atoms, results in the formation of a compound. Thus by mutual attraction higher creation comes into being in an ascending order. The presence of pair bonds amongst vegetable and fruits and amongst animals including man has been mentioned above in the verses 13:3, 31:10, 26:7-8 and 36:36.

The example of green Algae has been noted above.

Pair bonds in some monogamous animals have been studied recently. The desire for proximity to the partner and partner preference exists amongst animals. The mutual attraction مودّت between pairs زوجين is a remarkable

*The term مودّت is often termed as "love" or "affection". But love is a psychological phenomenon at the human level; it may be considered a specific form of "Mowaddat" but "Mowaddat" by itself is a much wider term.

phenomenon amongst them. Lampracht studied the fish, the Ciclid (Tilapia Mariae) a habitate of west African rivers. Here besides large groups, one frequently comes across pairs defending a territory. They will watch jointly over eggs the female has laid on stones and hollows.

The newly hatched larvae, still unable to swim are taken up in parents' mouths and carried to previously prepared sandpits in which they grow up into small fish that swim in a dense shoal around the parent fish. When danger looms the parent fish lure the shoal away from the danger point by a special jerk of the head. During the entire breeding cycle the partners stay together and there is hardly any aggression between them. It has been determined that this uniform external picture may depend upon two mechanisms. Until spawning male and female are held together by a sexually motivated bond. The partners remain significantly close to each other than to any other fish in the aquarium and try to surmount any obstacle separating them as a partition wall. They manifest a particular tolerance which is limited to their partner i.e., while there is total absence of aggression with respect to one another, they retain their belligerency towards intruders of their own species. After spawning and while looking after the brood, the pairs mainfest outwardly the same mutual tolerance, yet their behaviour is really controlled by another mechanism. No longer does sexual motivation hold them together but solely interest in the young. The parent fish keep a smaller distance from their offspring than they do from each other, they remain anywhere near each other. If the offspring is removed the pair splits up and fight each other. This shows they have a tendency to avoid each other during this phase. The end of the brooding period often overlaps the beginning of the next sexual phase. Courtship begins and animals are again interested in their old partner. They may thus remain together over many breeding sequences.

Parallel studies were conducted on the Shrimp Hymenocera Picta by Seibt and Wickler. Each pair of animal lives in a rocky cavity which is defended against any intruder. A male artificially separated from his partner will seek her even in the dark, provided olfactory contact is not impossible. Should he meet up with other females in the way, his search continues after cursory contact until he finds his former hidden mate. It may thus be concluded that the males know their mates individually, most likley by an olfactory signal. The female's specific scent must have become fixed in the male during the 'acquaintanceship' phase. If the female dies, considerable time lapses before a partner chooses another in the basin. Selection tests in a Y-tube demonstrate this capacity of the male to recognise his mate even more clearly. Placed before the tube branchings containing flowing water, the male must choose which branching will lead upstream to his invisible mate. The alternative stream flows past another female. But the male unfailingly chooses the branch leading to his mate, even if she is out of reach.

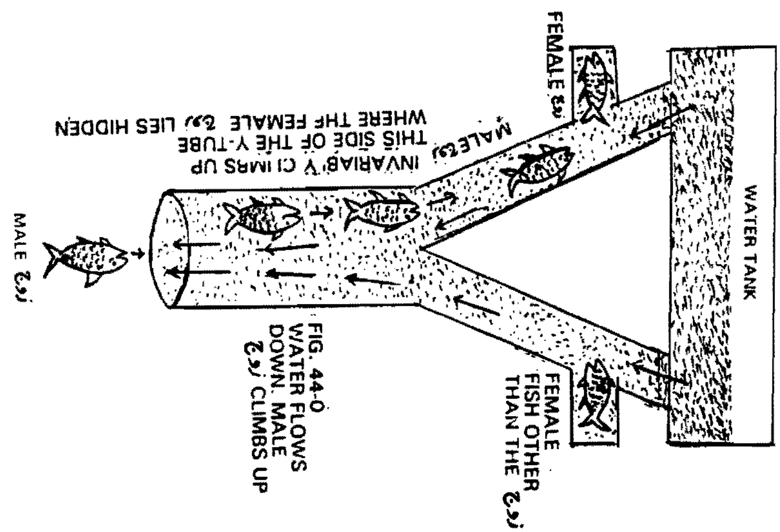


Fig. 44.--O

So far, about the attraction between the mates of Shrimp; but the purpose of their permanant togetherness could not be determined, because their partnership is neither due to sexual motivation, nor is meant for brood care. It is not meant for rearing the young, is apparent from the fact that the female carries the eggs under its abdomen and alone sees to it that the larvae are not attacked by fungoid growths, before they hatch. Also that the male does not keep contact with the offspring, nor does the male need the female to aid in hunting. Even mutual grooming is absent. And the male welcomes as sexual partner any female that has shed her carapace. When in fact a female does shed her carapace and exudes her characteristic attractive odour, all the males of her species in the vicinty are sexually stimulated and compete for the freshly stripped female. It is the strongest male who succeeds in copulating with her, not neccessary her own partner. Yet inspite of all this the attraction betwen partners persists. The biological significance of this capacity could not be ascertained.

Example 3--

A special form of partner -- restricted behaviour simultaneously facilitating partner synchronisation is presented here as a third example of study. This is the duet song of birds that pair for life. Duets are special pair songs, in which the partners' vocalisation fit together in time and motive. They are regarded as means of keeping the partner's together, of their finding each other after separation and of their synchronising them i.e., of conveying their motivation at a given moment. Duets occur in many bird species. A simple duet, that of a yellow breasted barbet, for example, consists of a few elements arranged in a stereotype pattern that is sung alternately by the partners forming a pair. Male and female have different calls which they sing in time with one another. Far more complicated is the duet of African drongo, studied by Von Helversen and Wickler. The drongo pair sings series of duets lasting for four to five minutes. Each duet contains up to twenty individual elements sung in a strictly alternating sequence. Nothing is so far known of the genesis of such reciprocal synchronisation. Young or widowed birds in search of a partner must evidently pass through a phase of acquaintance and adaptation until they are in such a good accord that a harmonious unbroken duet is possible. As this develops, it becomes more and more unlikely that they sing a duet with any other member of their species than the one they are attuned to. This seeking of an individual partner appears as pair bond. Perhaps the partners adapt to each other in other fields too i.e., in courtship display, care of the young etc.

What is the object of such a pair bond?

By dint of thorough filed observations, it has been found that in the case of some species of birds, well coordinated pairs have better success in breeding and rearing young than a newly formed pair. Thus permanent pair formations give these birds an advantage in selection. We have seen in the first example that in some Ciclids both parents are necessary for rearing young. So here again the pair bond has the same selection value. But the bond mechanism is different in different animals; in the case of drongo the bond exists directly between partners whereas with ciclids it is really directed at the offspring after spawning has been completed. The selection value in the case of shrimp Hymenocera picta is certainly of a differnet nature, for parents do not carry out rearing duties in common. Permanent monogamy may thus be realised via different mechanisms and also have different outcomes. It is also impossible to tie it up with any developmental level, for permanent monogamy exists side by side with other family structures. This is manifested particularly clearly in the case of our Zoological next of kin, the apes. The orangutan lives alone without a partner. The chimpanzee goes around in very loosely knit groups in which promiscuity prevails. The gorilla favours a harem, while the gibbon abides by a permanent monogamous family structure. If the particular family and social structures bear no relation to the level of development of a species, it is presumably bound up with ecological conditions. This being so, it should certainly be considered as a phenomenon of adaptation, an angle which is being closely investigated. If this is proved the question will arise as to whether different family structures are to be expected in the case of man, owing to varying conditions of his life.

The answer to this question from the Quranic point of view is, yes. The Quran recommends monogamy but allows polygamy under certain specific conditions. The conditional clause about polygamy introduces the rules for the marriage of orphans and widows. The immediate occasion for the promulgation of the verse about polygamy was after the battle of Uhd, when the Muslim community was left with many orphans and widows and some captives of war. Their treatment was to be governed by principles of greatest harmony and equity. The occasion is past but the principle remains.

The above said verse is as follows:-

وَإِنْ خِفْتُمْ أَلَّا تُقْسِطُوا فِي الْيَتٰمٰى فَانْكِحُوا مَا طَابَ لَكُمْ مِّنَ النِّسَاءِ مَثْنٰى
وَثُلٰثَ وَرُبٰعَ فَإِنْ خِفْتُمْ أَلَّا تَعْدِلُوا فَوَاحِدَةً أَوْ مَا مَلَكَتْ أَيْمَانُكُمْ
ذٰلِكَ أَدْنٰى أَلَّا تَعُولُوا ۝ (4:3)

"If you fear that you shall not be able to deal justly with the orphans, marry women of your choice, two, three or four; but if you fear that you shall not be able to deal justly (with them) then only one, or (a captive) that your right hand possesses. That will be more suitable, to prevent you from doing injustice".

Thus the Quran allows polygamy in man only for the sake of protection of female orphans and widows left after war which means the promotion of a condition of harmony and equity in the society; (Adl) justice and Ehsan being the fundamental principles of the Quranic society. Thus polygamy is allowed under special circumstances provided the man treats his wives with perfect equality, at least in material things. However equality in affection means putting one's self in an impossible position. The holy Quran says:

وَلَنْ تَسْتَطِيعُوا أَنْ تَعْدِلُوا بَيْنَ النِّسَاءِ وَلَوْ حَرَصْتُمْ فَلَا تَمِيلُوا كُلَّ
الْمَيْلِ فَتَذَرُوهَا كَالْمُعَلَّقَةِ ۚ وَإِنْ تُصْلِحُوا وَتَتَّقُوا فَإِنَّ اللّٰهَ كَانَ
غَفُورًا رَّحِيمًا ۝ (4:129)

"Permission to marry more than one wife was given subject to the condition that you hold the balance evenly amongst the wives (4/3). Allah knows that it will not be possible for you to hold the balance absolutely even, however keen you may be to do so. However, justice will be secured if you do not incline towards one wife in such a way that another is left as if she were suspended. If you observe fairness and be mindful of Allah's laws, you will secure protection and nurture from Him".

But if one is not able to do that much even, he is not allowed to marry more than one woman. Thus according to the Holy Quran monogamy is the rule but polygamy is allowed under specific conditions to meet the abnormal situation.

It is apparent from what has been described above that the purpose of pair bonds in animals differs from one another. The purpose in the case of man as given in the Quran, is as follows:

وَمِنْ آيَاتِهِ أَنْ خَلَقَ لَكُم مِّنْ أَنفُسِكُمْ أَزْوَاجًا لِّتَسْكُنُوا إِلَيْهَا وَجَعَلَ بَيْنَكُم
مَّوَدَّةً وَرَحْمَةً ۚ إِنَّ فِي ذَٰلِكَ لَآيَاتٍ لِّقَوْمٍ يَتَفَكَّرُونَ (30:21)

"And among His signs is this, that we created for you ازواجًا mates, that you may dwell in *tranquility* with them and He has put مودّةً *mutual attraction* and *means* of *development of each other's potentialities*. Verily in that are signs for those who reflect".

Without peace of mind, tranquility and mutual affection parents are not able to fulfil their responsibilities for the development of the body and the mind of their chidlren. These requirements can not be met with in polygamy. On the other hand, man by the misuse of his freedom of choice may either follow chimpanzee and form a loose-knit society where promiscuity prevails, or may follow gorrilla and form 'harems'. But the natural pair-bond, consistent with the divine guidance, is by means of monogamy.

Meiosis. As noted already, every organism has got a fixed number of chromosomes per cell and the number remains constant through successive generations. Apparently if the male and female gametes of a particular species, containing the same number of chromosomes as somatic cells, combine to form a zygote, the number of chromosomes would become double and it shall go on doubling after every successive generation. Actually this does not happen. The number of chromosomes in the cells of successive generations of a species remains the same. The doubling is prevented by a process of special nuclear division, known as *Meiosis*.

The cells in the sex organs of male and female undergo maturation before they form gametes. A cell before maturation contains the original number of chromosomes specific to its species. This number is called a Diploid number and its symbol is $2n$. The chromosomes in a diploid $2n$ cell consist of exactly similar two different sets, one from male side and the other from female side. In other words a zygote does not contain a $2n$ collection of mutually different chromosomes but instead a collection of mutually different pairs of chromosomes (Fig. 44). After maturation the number is reduced to one half. This is called a haploid number and its symbol is $1n$.

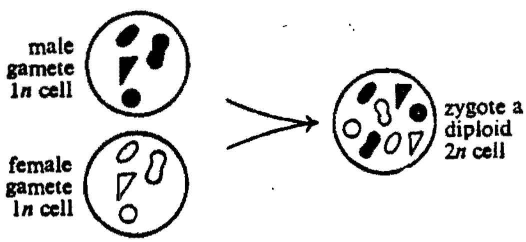


Fig. 44.--A Diploid $2n$ cell contains two like sets of chromosomes representing

For example in man 46 is the diploid number and 23 the haploid number. In this haploid cell it is entirely a matter of chance as to which and how many chromosomes are maternal or paternal in origin (Fig. 45).

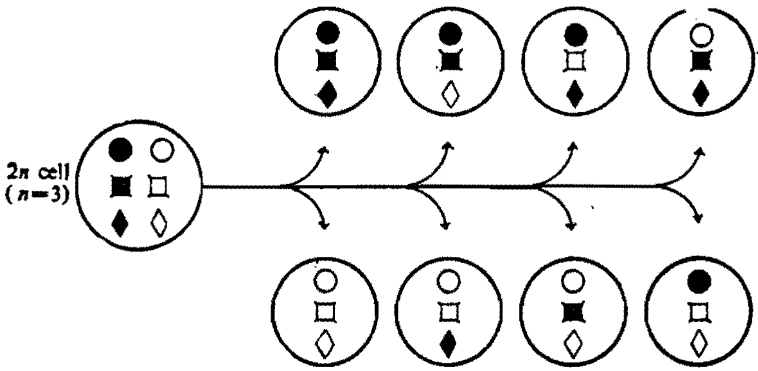


Fig. 45.--PATERNAL-MATERNAL CHROMOSOMES' COMBINATION.

When the chromosome number of a diploid cell is halved by meiosis, any resulting haploid cell contains a single set of chromosomes consisting of a chance determined number of paternal and maternal chromosomes. Various paternal-maternal combinations are shown here.

Meiosis occurs in all organisms which have sexual reproduction but the stage at which it occurs in the life cycle of different organisms differs. In many protista meiosis takes place at the zygote stage (Fig. 46). In these cases zygote is the only diploid stage. Fertilisation produces a zygote with a diploid chromsome number and meiosis then restores it to haploid condition which continues in the offspring cell till it unites again to form a zygote. But the case is different with all the multicellular animals. For example, in man, the gamete-producing cells of the sex organs are diploid and meiosis occurs during the process of gamete formation producing haploid gametes. When a male gamete fertilises a female gamete, the zygote formed by the combination of the two becomes diploid. As the zygote develops into a mature human being all the cells of the body remain diploid.

Thus in protista the meiosis occurs after zygote formation and in multicellular animals it occurs before zygote formation.

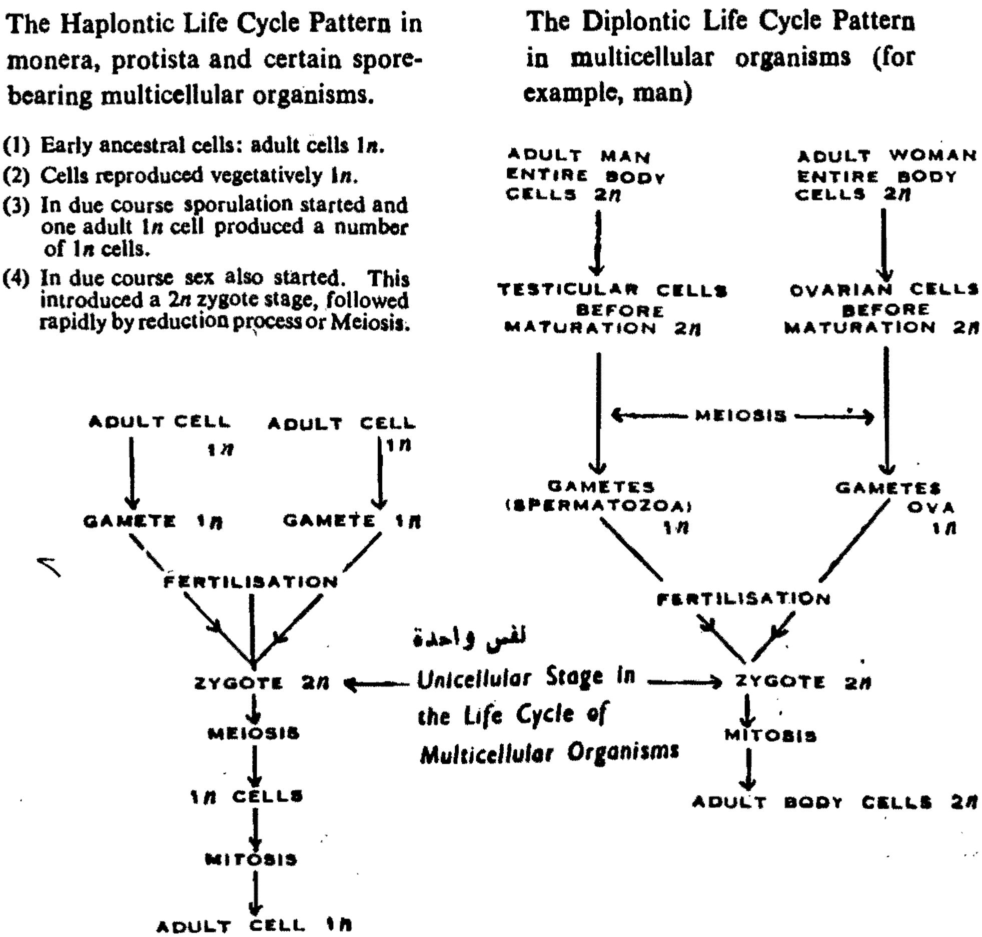


Fig. 46.--THE HAPLONTIC AND DIPLONTIC LIFE-CYCLE PATTERNS IN ORGANISMS.

All organisms reproduced by sex must pass through a unicellular stage during reproduction and that stage is ZYGOTE which the Holy Quran calls نفس واحدة . Zygote, the reproductive unit is always 2*n*.

نفس واحدة . The term نفس واحدة as it occurs in the Holy Quran, in relation to the creation of man, shall be discussed fully in Chapter XII. But we must take note at this juncture that the Quran has used this term for "a fertilised ovum" or Zygote which is a complete reproductive unit, and which serves as an important landmark in the propagation of successive generations of organisms which are reproduced by means of sexual process. It is a unicellular stage in the life cycle of all multicellular organisms, including man. Whenever a new life starts, it starts from this unicellular stage.

The Process. Meiosis consists of two nuclear divisions, that follow one another without any interval, known as first and second meiotic divisions. These have many features in common with mitotic division. The prophase, metaphase, anaphase and telophase stages of cell division are common to both. The difference arises in the metaphase stage of first meiotic division.

As noted already, in mitosis all chromosomes, each of them already duplicated, migrate into the metaphase plate, where they line up in the same plane.

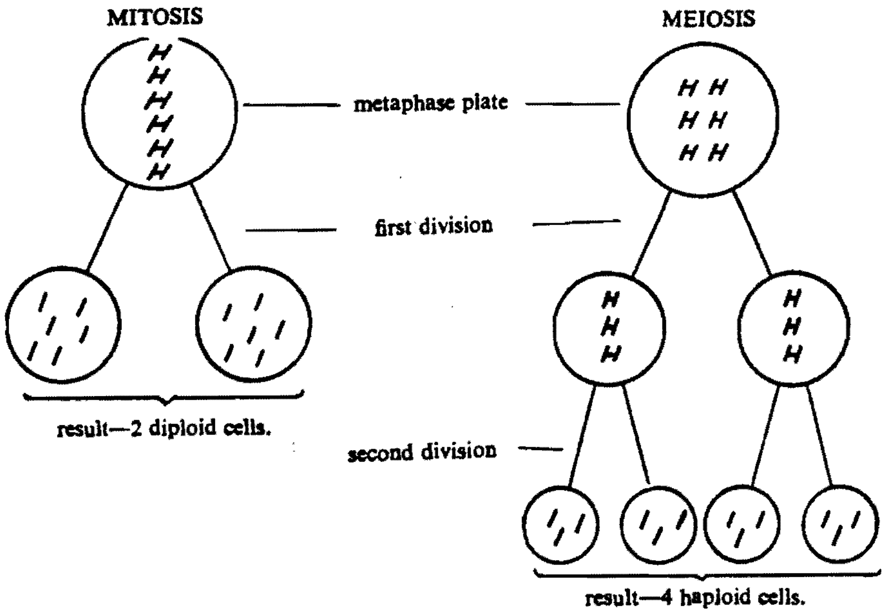


Fig. 47.--DIFFERENCE IN THE METAPHASE PLATES OF MITOSIS AND MEIOSIS.

In the first meiotic division, however, all duplicated chromosomes line up not in one plane but in two parallel planes in the middle (Fig.47). Supposing in one particular species there are six $2n$ chromosomes in each cell. Out of these 6 duplicated chromosomes, 3 shall line up in one plane and 3 in the other. In the Anaphase of mitotic division, every duplicated chromosome gets divided at the centromere and an equal number of divided chromosomes migrate towards the opposite pole. In first meiotic division, however, the undivided duplicated chromosomes arranged already in two different planes now migrate towards their respective poles, so that in the particular species described above, 3 will go to one pole and 3 to the other pole, thus forming two cells.

In the second meiotic division, however, the process shall be the same as in mitotic division i.e., all the three duplicated undivided pairs resulting from the first division, line up in one plane in metaphase; and in anaphase divide at the centromeres and migrate towards the opposite poles. Thus all the 4 resulting cells shall contain 3 haploid chromosomes each.

CHAPTER XII

Self-Perpetuation: Reproduction

REPRODUCTION AMONGST MULTICELLULAR ANIMALS

(31:28) ...مَا خَلْقُكُمْ وَلَا بَعْثُكُمْ إِلَّا كَنَفْسٍ وَاحِدَةٍ

"Your creation and your recreation is in no other way but as a single life cell."

(96:1-2) ...اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ ۝ خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ ۝

"Proclaim the attribute of 'Rabubiyyat' of thy Sustainer, Who created (the universe), and created man out of علق *a hanging mass."*

Multicellular animals reproduce themselves both asexually as well as sexually. Asexual processes are budding and regeneration. Often, as in Hydra, a bud grows out from the body of the animal and when completely differentiated, frees itself from the parent. In some animals when a part of the body is separated by injury, it regenerates and grows into a complete normal animal. Sponges are especially remarkable in this respect. Cuttings of sponges will grow and develop into complete sponges such as cuttings of plants do. In crayfish, snail and starfish, the parts lost by injury die, but they become replaced by regeneration. In higher animals including man the only remnant of regeneration or vegetative reproduction is wound-healing.

SEXUAL REPRODUCTION

In certain species such as flatworms and earthworms both male and female reproductive organs are located in one individual. These animals are called Hermaphrodites. But the multicellular animals mainly reproduce themselves sexually by forming gametes; the male and female gametes being formed in different individuals. In males they are formed in testes and in females in ovaries. There are specialised germ cells in the gonads (testes and ovaries) which produce gametes. The gonads appear during embryonic development of some animals but do not enlarge until the individuals approach sexual maturity. In others they form at a later stage. At the approach of maturity the germ cells multiply rapidly, they are then called spermatocysts in the male and oocysts in the female. The spermatocysts and oocysts undergo a process of maturation before they become spermatozoa (the male gametes) and ova (the female gametes) respectively. The process of maturation involves both nucleus and cytoplasm. Nucleus maturation consists of meiosis. A spermatocyst is a diploid $2n$ cell and by meiosis it forms four haploid $1n$ cells, all of which become functional spermatozoa (Fig.48). In a female a diploid oocyst forms two cells in the first meiotic division, one large and the other small. The latter soon degenerates and is known as first polar body. The former passes through second meiotic division and again produces one large and one small cell. The former becomes an ovum or egg, the latter again degenerates and forms the second polar body. The two polar bodies remain attached to the egg.

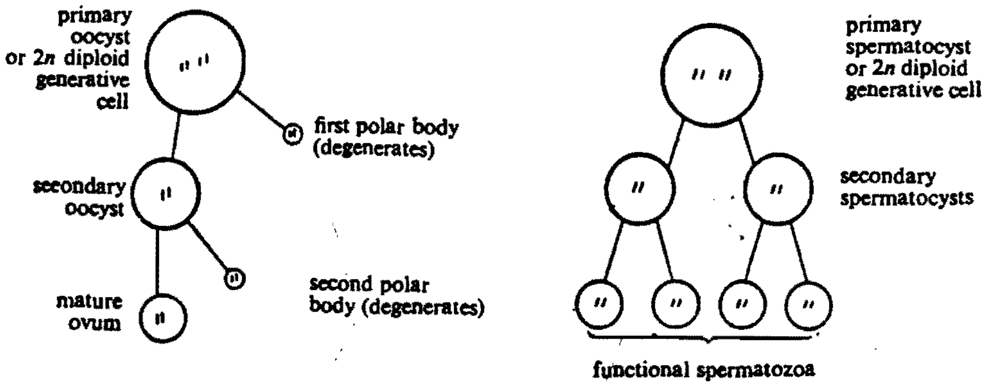


Fig. 48.--MATURATION OF GENERATIVE CELLS IN METAZOA BY THE PROCESS OF *MEIOSIS*.

Parallel with the nuclear changes, cytoplasmic changes take place which differ in different animal groups. In the spermatogonia of vertebrates most of the cytoplasm degenerates and the sperm produced consists of a head which arises from the nucleus, a long tail, a neck or middle piece between the head and the tail, and a structure known as Acrosome at the fore end of the head. The tail, neck and the acrosome are of cytoplasmic origin. The tail functions as a locomotary organ, the neck contains mitochondria, and with acrosome the sperm makes its first contact with the ovum. A mature sperm is one of the smallest cells of the body (Fig.49).

The mature ovum or egg is amongst the largest cells of an animal body, but its size varies much in different species. The size of the egg in animals is determined, chiefly, as to whether the developing embryo is mainly dependent on food stored in the cytoplasm of the egg, or upon some outside source such as the sea water in which it floats, or the tissues of the parent. The first condition we find in a bird's egg, which is very large. On the contrary, the human egg is very small, about 1/175" in diameter (Fig.50).

Parthenogenesis. Some eggs develop without the entrance of a sperm, as in rotifers, ants, bees and wasps. This gives rise to fatherless offspring. The process is known as parthenogenesis.

Polyembryony. Two or more individuals may be produced from one egg by separation of the cells in early stages of cleavage. This occurs in case of identical twins in man. Twins developing from two separate ova are called fraternal twins. The process is called Polyembryony.

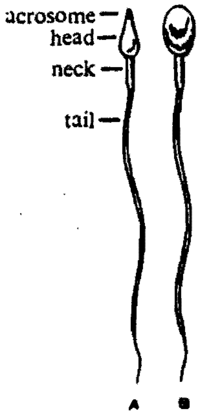


Fig. 49.--SPERMATOZOON.
A--prfile view.
B--surface view.

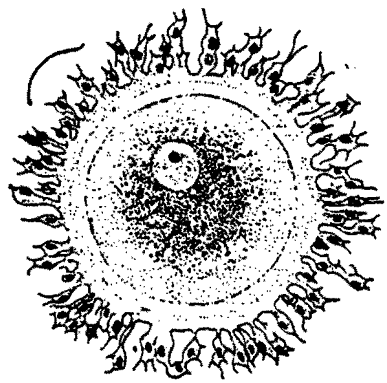


Fig. 50.--MTURE OVUM.

Breeding Seasons. Most species of animals, like plants, reproduce in certain seasons known as Breeding Seasons. The time correlates with a particular seasonal temperature and availability of food. In cold and temperate regions, the breeding season is usually spring or summer when food is abundant and the conditions for the survival of offspring are favourable. Other species are influenced by the kind of food. In some birds and mammals the increasing length of daylight acts on the gonads through the pituitary gland to induce breeding. Apes and men, however, produce gametes all the year round. Perhaps this is because man has adapted to the control of his environments better than any other animal.

Patterns of Mating and Fertilisation

External Fertilisation. In aquatic animals water is always available for sperm distribution. Amongst land animals, the amphibians such as frogs and toads also migrate to natural bodies of water for sperm release. The male and female come close to each other. The female spawns, i.e., releases eggs directly into the water and the male releases sperms over them. Thus many fertilisations occur by chance union of closely placed male and female gametes (sperms and ova). This is known as External Fertilisation. The zygote here develops in water.

Internal Fertilisation. On the other hand, in land animals such as mammals and birds, the mating partners come into physical contact with each other and the copulating organ of male transfers swimming sperms directly into the reproductive system of the female. This is known as Internal fertilisation.

Patterns of Egg Release

(1) In most animals e.g. insects, birds and aquatic invertebrates the females lay eggs (i.e. release outside) from which the offspring later hatch out. These animals are known as *Oviparous*. The eggs here develop on their own, as there is abundant food supply inside the egg in the form of yolk. Many fishes and amphibians are oviparous and externally fertilising. On the other hand, birds are oviparous but internally fertilising.

(2) There are animals like sharks, lizards, certain insects and snakes in which fertilisation is internal, the fertilised egg develops on its own food supply, as in bird's egg, but after fertilisation the zygote is retained within the female reproductive system. The female body, however, only gives protection to the developing zygote and does not contribute to its development. These animals are called *Ovoviviparous*.

(3) In a third variety of animals the fertilisation is internal and the zygote after fertilisation is retained in the female reproductive system. The female body here not only gives protection but also provides nourishment to the developing zygote and a developed animal is born after a specified term. These animals are known as *Viviparous*. Mammals are the principal viviparous animals.

REPRODUCTIVE SYSTEMS

The reproductive system in animals basically consists of a pair of gonads connected with a system of ducts which lead to the exterior of the body. The reproductive ducts of a female usually carry the eggs from the gonads (ovaries) directly to the outside, or to a cloaca, or to uterus. The male ducts are usually one or two vas-deferentia which carry the sperms directly to the outside or into an ejaculatory duct. The male ducts are often enlarged near the posterior end into seminal vesicles where sperms are stored until needed and seminal receptacles may be present in the female for the same purpose. In many animals glands are attached to the gonads and their ducts.

The Male Reproductive System in Man. The male genital organs include testes and Epididymides, the Vas-deferentia (or spermatic ducts), Ejaculatory ducts and Penis; the Prostate gland and Bulbo-urethral glands (Fig.51).

In human males, the testes are suspended in the scrotum, by spermatic cords. The glandular structure of the testes consists of lobes of the testes (Fig.52). Their number is estimated to be about 400. Each lobe consists of from one to three or more convoluted tubes, termed the Seminiferous tubules. The lobes are separated and supported by loose connective tissue which contains here and there groups of

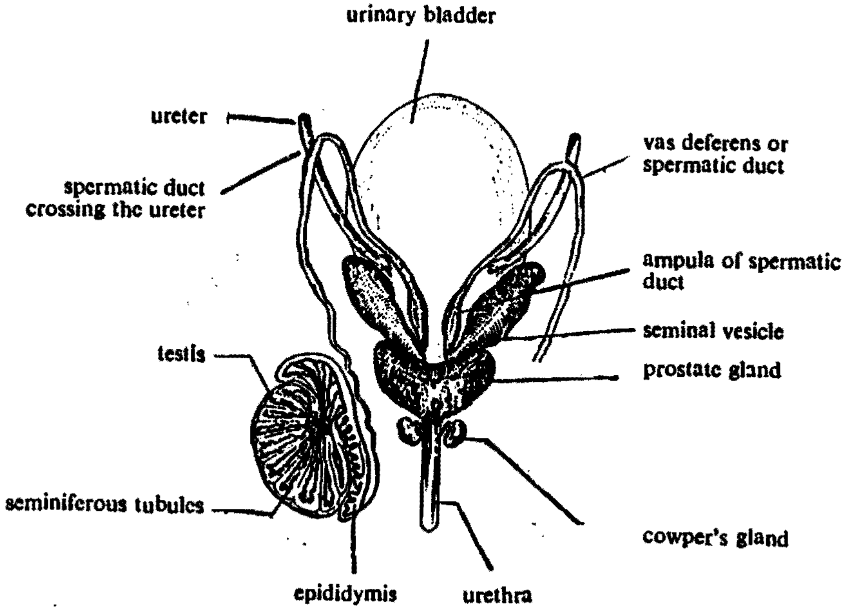


Fig. 51.– THE MALE REPRODUCTIVE SYSTEM (in man).

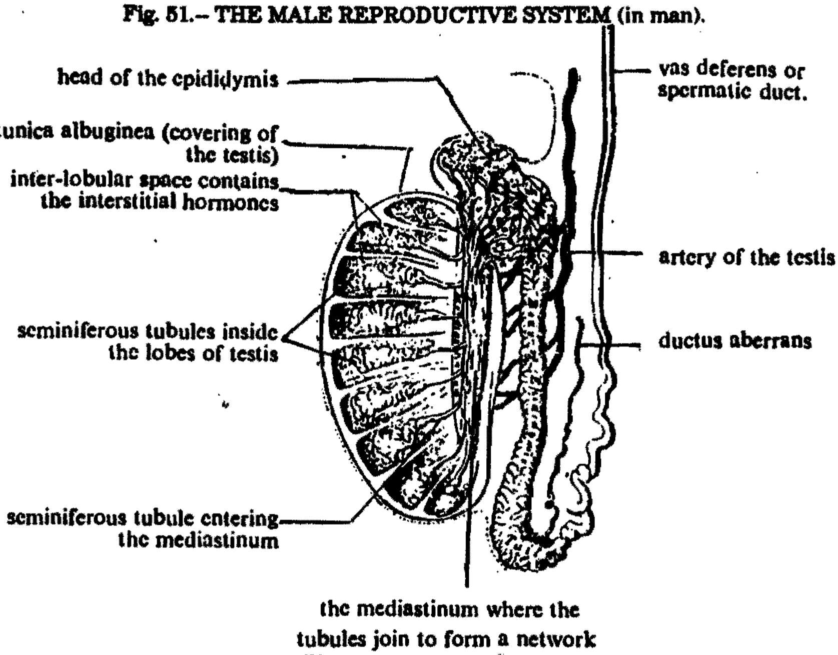


Fig. 52.–THE TESTIS.

specialised endocrine cells which manufacture Androgen, the male sex hormone. The sperm producing tissue of the testes is located in the seminiferous tubules. The cells lining these tubules divide mitotically at a great rate. New cells so formed then accumlulate in the interior of the tubules and there they mature into sperms.

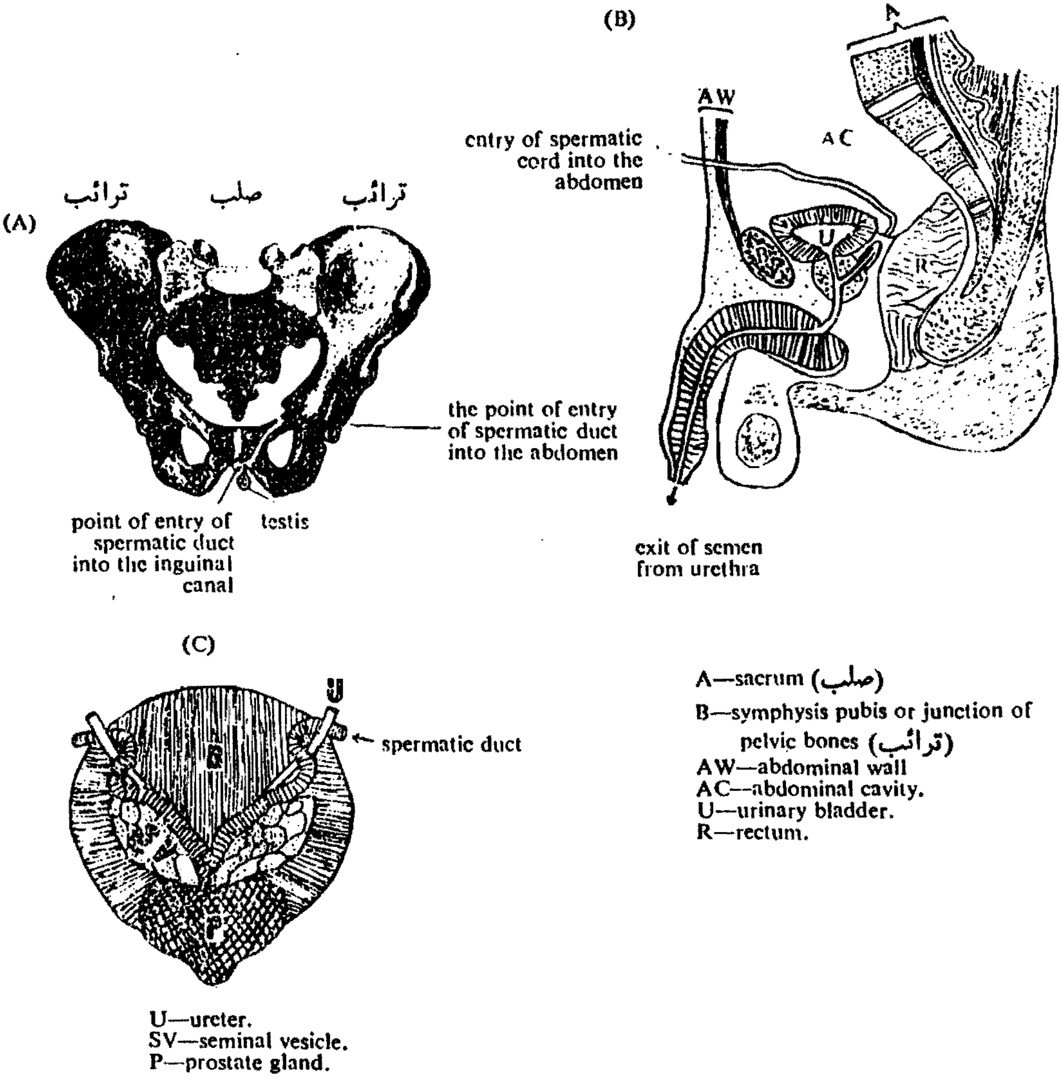


Fig. 53.–THE COURSE OF VAS-DEFERENS (spermatic duct). extra and intra-abdominal.

(A) 1st stage–The extra-abdominal course–The duct leaves the testis; passes through the inguinal canal (white line), and enters the abdomen.

(B) 2nd stage–(lateral view). Intra-abdominal route of spermatic duct. The duct enters the abdomen, joins the prostatic part of the urethra which carries the semen to the outside. Here the course of seminal fluid lies between the Sacrum (صلب) behind, and the Pelvic bones (ترائب) in front.

(C) Terminal part of spermatic ducts before they enter the prostatic urethra.

Newly formed sperms do not lash their tails. The tubules of each testes unite to form the Epididymis, a much coiled tubule about 20 feet long. The Epididymis leads into a common sperm duct called Vas-deferens which emerges from the testes. The Epididymis stores sperms which are crowded out from the testicular tubules. During copulation, nerve impulses may bring about contraction of the muscular walls of the Epididymis and then the collected sperms are propelled forward into the straight part of the Vas-deferens (or sperm duct). This part of the duct leaves the scrotum and passes through the groin in the spermatic cord where it joins the other structures of the cord such as blood vessels etc. Then passes through the muscles of the abdominal wall by means of an oblique aperture and enters the abdominal cavity (Fig.53). It separates from other structures of the spermatic cord, is directed backwards, crosses the ureter and reaching the medial side of this tube bends at an acute angle. Lastly it passes downwards to the base of the prostate gland and is joined at an acute angle by the duct of the seminal vesicle. Then it joins the vas deferens of opposite side and ultimately opens into the prostatic portion of the urethra, close to the point where the urinary bladder also opens into it. Near its termination the duct receives watery secretions from the seminal vesicles and from the prostate gland. These secretions together with the sperms, constitute semen. It is here that the sperms begin to lash their tails. The semen thus passes from the prostatic urethra, through the penile urethra to the exterior. It is apparent that the seminal passage in the pelvic cavity lies between the anterior and posterior segments of the pelvic girdle.

Let us consider, in this respect, the following verses of the Holy Quran:

فَلْيَنظُرِ الْإِنسَانُ مِمَّ خُلِقَ ۝ خُلِقَ مِن مَّاءٍ دَافِقٍ ۝ يَخْرُجُ مِن
(86:5-7) بَيْنِ الصُّلْبِ وَالتَّرَائِبِ ۝

"Now let man see from what he is created. He is created from a spurting fluid, that emerges from between the anterior and posterior segments of pelvic girdle."

Nobody except the one who knows human anatomy can put forth the above description. And just imagine from which institute of anatomy the unlettered Messenger of Allah (peace be upon him) learnt this anatomical point in the sventh century A.D.!

The position of Testes inside the animal body differs with the different animals. For example in Opossum the testes are situated permanently inside the abdominal cavity, at the same position as ovaries in females. The testes in elephants are also situated inside the abdominal cavity but they descend into the scrotum during breeding season when sperms are actually produced. After the breeding season they again return into the abdominal cavity. In man the testes are inside the abdominal cavity during embryonic stages but they descend into the scrotal sacs before birth and remain there permanently. The temperature inside the scrotal sacs is low as compared with the abdominal cavity. It is also known that the sperm production increases in low temperature. Possibly sperm production, location of testes and low temperature are related to one another.

The Female Reproductive System in Man (Fig.54). The Ovaries of human females are a pair of organs, each being about 3 cm long and 1.5cm wide and are situated on each side of the uterus in relation to the lateral wall of the pelvis. They are partially enveloped by the funnel-shaped terminals of the Oviducts, also called Fallopian tubes. These tubes, lined by cilia internally, open at the other end into the uterus. The embryo develops in the Uterus which is a muscular organ and is capable of stretching and enlarging considerably during pregnancy. The mouth of the uterus called Cervix opens into the Vagina which in turn opens outside. In contrast to the arrangement in males, the reproductive tract in females is entirely separate from the urinary tract.

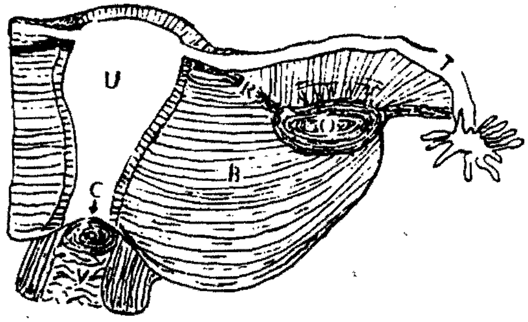


Fig. 54.—THE FEMALE REPRODUCTIVE SYSTEM (in man).

U—uterus. T—oviduct or fallopian tube.
O—ovary. R—round ligament.
C—cervix. B—broad ligament, in which ovary is suspended.
V—vagina.

The outer layers of the ovaries are the egg-producing tissues. As in testes new cells are manufactured mitotically and are crowded into the interior of the organ. But whereas in testes all spermatogonia mature into spermatozoa, in the ovary, all oogonia do not become eggs. In a given batch of newly produced cells all of which are probably potential eggs, usually only one actually matures into a reproductive cell. Meiosis occurs in such a cell and its cytoplasm enlarges and accumulates some yolk. The surrounding cells are inhibited in some unknown way, from maturing into eggs. However, these surrounding cells acquire other functions, they specialise as endocrine tissue and secrete Estrogens or the female sex hormones.

Man made the greatest discovery about himself when Von Baer discovered the human ovum with the aid of microscope in 1827. The human egg although insignificant in size, as compared with birds or other animals, is the largest cell of the human body, its size being 117 to 142 micromillimeters or 1/175 inch. It has a large amount of protoplasm and a large nucleus. It contains reserve food or yolk. Only one ovum is discharged in one menstrual cycle. Spermatozoa on the other hand are small cells, completely devoid of reserve food. They are highly mobile and are produced in enormous numbers. The length of human spermatozoa including tail is 52 micromillimeters. It is significant that spermatozoa have tails. Nobody would have recognised their wonderful relation with the ovum if they had been tail-less.

Fertilisation. Once it is discharged from the male reproductive system, a sperm can live only a few hours. similarly eggs discharged from the ovary do not persist for more than a few hours. The time of greatest fertility in man therefore concides roughly with the time of ovulation. Normally the egg enters the fallopian tube and travels down through it towards the cavity of the uterus. If semen is introduced into the vagina at this time, some of the sperms will ascend through the uterus into the fallopian tube where one will meet and fertilise the descending egg (Fig.55).

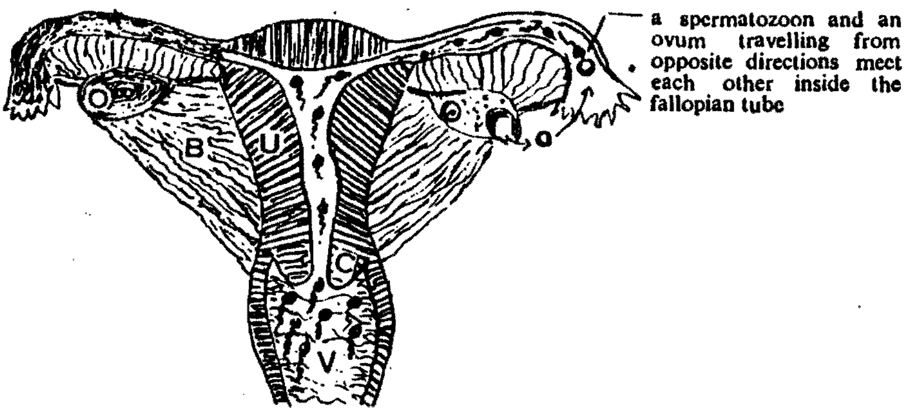


Fig.55--UNION OF SPERM AND EGG.

A large number of sperms travelling from the vagina (V), via the uterine cavity, into the fallopian tube. The first one to meet the ovum, entering from the ovarian end of the fallopain tube, fertilises it. U--uterine wall.

Only one sperm unites with the egg but sperms in males of all species are produced in enormous numbers. In man an average ejaculation of semen contains about 400 million sperms, a number sufficient to fertilise 400 million women, if every sperm is used. On the other hand we know that only one sperm is required for fertilising a woman. It is also a well known fact in medicine that a man may be sterile if he produces a smaller quantity of semen, or if the number of sperms per cubic centimeter is smaller. The question arises: what is the function of such a large number of sperms that are being created? As a matter of fact the task before them is long and hard and can only be accomplished if they are in a great strength. The first obstacle in their way is the mucus plug in the cervix of the uterus. The sperms produce an enzyme which dissolves the mucus. Every sperm produces a small bit of the enzyme and it is by the combined effort of many that they are able to remove this obstacle out of their way and enter the uterine cavity, where the folds of mucous membrane serve as mountain barriers for the tiny sperms. Again an enormous number of sperms explore its vast area and those capable of enduring the rigours of this commando exercise and lucky enough to find the minute doorway of fallopian tube, enter it and travel along it, until they come across a recently ovulated ovum.Here another obstacle comes in their way. The ovum is surrounded by a corona of cells which are cemented together. Again this cement must be dissolved before the sperms can reach the ovum and again it requires a combined effort because a sufficient quantity of enzyme is required.

Once this barrier is broken the sperms envelop the ovum like a swarm of bees in attendance on their queen. As soon as the first sperm comes into functional contact with an ovum, the first reaction is to prevent the entrance of other sperms so that the first arrival may have free field of operation. A membrane, known as fertilisation membrane, has already been formed on the surface of the ovum during maturation (Fig.56). The egg secrtetes some fluid immediately after the sperm tip or acrosome gets adhered to the ovum. This raises up the fertilisation membrane. The sperm loses its tail and its head is trapped in between the membrane and the egg surface. Thus the sperm does not bore into the egg surface but is rather engulfed by it. This statement is further supported by the fact that certain ova, for example of sponges, are amaeboid.

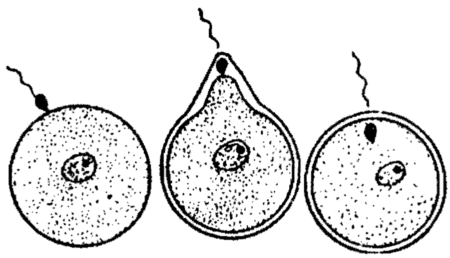


Fig. 56.—FERTILISATION OF OVUM (activation).

When a sperm comes into contact with an ovum, a membrane is raised over its surface, which prevents entry of other sperms.

Along with these surface changes, profound changes occur in the cytoplasm which shrinks and loses water; and special protoplasmic materials flow to difinite regions inside the egg. These changes are eclipsed by other important events.

The egg at this stage is only activated. Fertilisation has not started yet. A mature egg has got the potentialities for development but the development does not start unless the egg receives a specific stimulus. Eggs of frog develop without fertilisation, if they are stimulated artificially and thus produce fatherless offspring.

The climax of fertilisation is the union of male and female gametic nuclei. The sperm nucleus moves towards the centre of the egg where the two nuclei meet. The membranes of both the gametic nuclei get dissolved and their chromosomes lie free in the cytoplasm. The two centrosomes each surrounded by an aster appear and take up positions on either sides of the chromosomes. The chromosomes now diploid in number line up in metaphase plate and the zygote undergoes its first mitotic division forming two cells (Fig.57). These two cells divide and subdivide,taking the first step towards pregnancy.

Quran on the Origin of Man from Fertilised Ovum نفسٍ واحدة.

As noted earlier, a zygote or fertilised ovum forms a complete reproductive unit, a landmark in the propagation of successive generations of plants and animals produced by sexual reproduction, including man. The cells of any new generation male or female, originate from a single cell, the zygote. Again it may be pointed out at

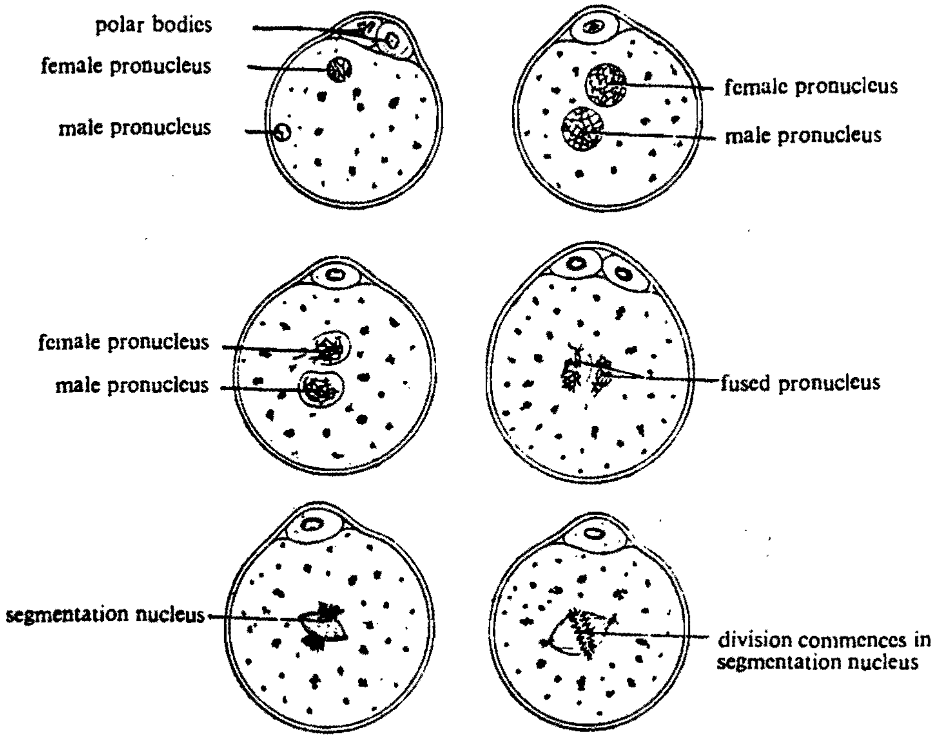


Fig. 57.--FERTILISATION OF OVUM (fusion of nuclei).

this juncture that the cell theory was initiated by the biologists in the year 1838-1839 and all the research in this field has been done thereafter.

But the unlettered Messenger of Allah (peace be upon him) declared in the 7th century A.D.:

وَهُوَ الَّذِىٓ اَنْشَاَكُمْ مِّنْ نَّفْسٍ وَّاحِدَةٍ فَمُسْتَقَرٌّ وَّمُسْتَوْدَعٌ ط ... (6:99)

"He it is Who has given you (man) a new life from a single cell, placed in its temporary abode for a particular period, for disposal to its next stage."

خَلَقَكُمْ مِّنْ نَّفْسٍ وَّاحِدَةٍ ثُمَّ جَعَلَ مِنْهَا زَوْجَهَا ...

(39:6)

> "He created you (man) from a single life cell and made from it its opposite sex."

... الَّذِي خَلَقَكُمْ مِّنْ نَّفْسٍ وَّاحِدَةٍ وَّخَلَقَ مِنْهَا زَوْجَهَا وَ
بَثَّ مِنْهُمَا رِجَالًا كَثِيرًا وَّنِسَاءً ...

(4:1)

> "He created you from a single life cell and made from it its opposite sex and from them has spread abroad a multitude of men and women."

This process of creation and recreation from a single cell (fertilised ovum) continues through successive generations. Every time a new life starts, it starts from a single cell. The following Quranic verse makes this point abundantly clear:

مَا خَلْقُكُمْ وَلَا بَعْثُكُمْ إِلَّا كَنَفْسٍ وَّاحِدَةٍ ...

(31:28)

> "Your creation and recreation is in no other way but as a single cell."

It may be pointed out here that, influenced by the story of creation as related in the Jewish literature, a majority of our commentators have made a serious mistake in the interpretation of the above verses. They maintain that the human species has grown from a single individual, named Adam, a male, and out of him was created another individual of the above oppposite sex, Eve, a female; and by the union of those two the human species came into existence. This view has got no support either from Quran or from science.

The Holy Quran described the stage at which sex appears in the following words:

وَأَنَّهُ خَلَقَ الزَّوْجَيْنِ الذَّكَرَ وَالْأُنْثَىٰ ۝ مِنْ نُّطْفَةٍ إِذَا تُمْنَىٰ ۝
وَأَنَّ عَلَيْهِ النَّشْأَةَ الْأُخْرَىٰ ۝

(53:45-47)

> "He created the sexes male and female from a reproductive unit when lodged in its place and surely the appearance of later creation is according to the laws initiated by Him."

Earlier we have described the phenomenon of asexual reproduction in different organisms. But the creation of man originated after the stage of sexual reproduction came into being. The reproductive units contributed by males and females passed through various evolutionery stages, manifesting each time fresh sets of potentialities, until a stage was reached when man with the faculties of hearing and sight appeared on the scene. The Holy Quran makes it abundantly clear:

إِنَّا خَلَقْنَا الْإِنسَانَ مِن نُّطْفَةٍ أَمْشَاجٍ نَّبْتَلِيهِ فَجَعَلْنَاهُ سَمِيعًا بَصِيرًا (76:2)

> "Verily We created man from a drop of mingled fluid (with all the potentialities of becoming a man). Then We caused it to pass through various (evolutionary) stages, until We made him one possessing the faculties of hearing and sight."

The point shall be explained further in the chapter on Evolution.

PREGNANCY

This is the process of development of zygote after fertilisation نفس واحدة, inside the mother's uterus. Again we take man as an example. As noted above, fertilisation in human female occurs in the upper part of the fallopian tube and is followed immediately by division of zygote. This division and redivision occurs at a great speed until it forms a mass of cells called *Morula* (Fig.58). The Morula soon comes to consist of two groups of cells. One group in the centre of the mass represents the embryo proper. These cells give rise to future offspring. Surrounding the central group are cells which do not become part of the offspring body as such. Instead the cells form the *Extraembryonic Membranes*. This stage where a cavity is formed within the morula, is called a *Blastocyst*. Simultaneously with these changes the cellular mass is gradually carried along the fallopian tube by the action of cilia which are located in its lining membrane. It takes about a week to reach the uterus. The blastocyst is deposited on the inner surface of the uterine wall

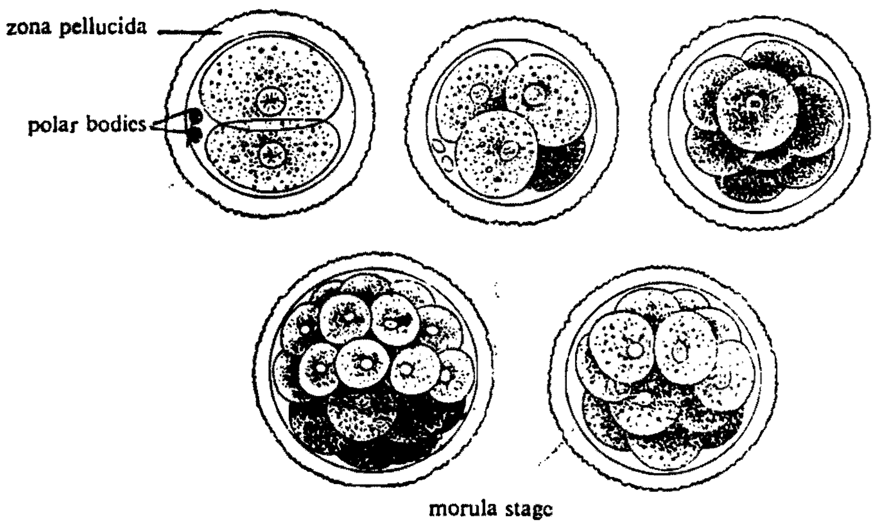


Fig.58.--SEGMENTATION OF FERTILISED OVUM.

which has been prepared for its reception by progesterone (the hormone secreted by Corpus Luteum). The blastocyst next becomes implanted in the wall of the uterus, i.e., it is gradually surrounded by uterine tissue. The Corpus Luteum persists for roughly the first twelve weeks of pregnancy. During this phase the progesterone output increases and the uterine lining becomes even more glandular and vascularised. Extraembryonic membranes do not form in the development of fish or amphibian embryos. In the history of evolution they first appeared in reptiles and then in birds and mammals. As reptiles were the first animals to lay eggs on land, this new feature was an adaptation to protect the embryo against desiccation and physical shock during development. Reptiles and birds are oviparous and lay shelled eggs. The shell is porous enough to allow the exchange of gases but not the passage of water. The extraembryonic membranes are *Chorion, Amnion, Allantois* and *Yolk Sac* (Fig. 59). The Chorion, lying all round inside the shell, covers the other three membranes. It prevents evaporation of water. The Amnion covers the embryo on all sides except the ventral surface. The amniotic cavity is filled with lymph-like fluid in which the embryo lies. This is equivalent to the fresh water ponds in which the ancestors of reptiles developed. Allantois arises from the ventral surface of the embryo and comes into contact with the egg shell. It serves as a lung for the embryo, as gas exchange takes place between it and the air surrounding the shell. It also serves as an excretary organ, as the waste products go on accumulating in its interior till the time of hatching. Yolk sac also lies on the ventral surface of the embryo. It stores yolk or food for the embryo and gradually gets smaller with the consumption of food.

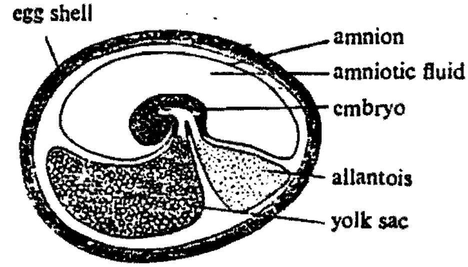


Fig. 59.—THE EXTRAEMBRYONIC MEMBRANES (in the eggs of reptlies and birds).

Mammals, except the egg laying mammals, are viviparous. Their eggs are not released outside but develop inside the mother's uterus and are without shell. Here the shell is unnecessary because the egg is well protected. Secondly, the extraembryonic membranes in mammals have adapted different functions. The chorion develops branched finger-like projections which get embedded into the uterine tissue (Fig.60). This gives rise to the formation of placenta, through which the embryonic blood vessels come into contact with the maternal blood vessels giving rise to mutual exchange of materials between the two bloods. Oxygen and nutritive materials pass from the mother's blood to the embryonic blood and the embryonic waste products pass in the opposite direction. As the functions of nutrition, respiration and excretion are now all carried out through placenta, the allantois and yolk-sac both become superfluous and rudimentary, the allantois though still serves as a passage for the embryonic blood vessels to the placenta. The amniotic fluid however continues to serve as a private pond and shock absorber for the embryo as in the case of reptiles and birds.

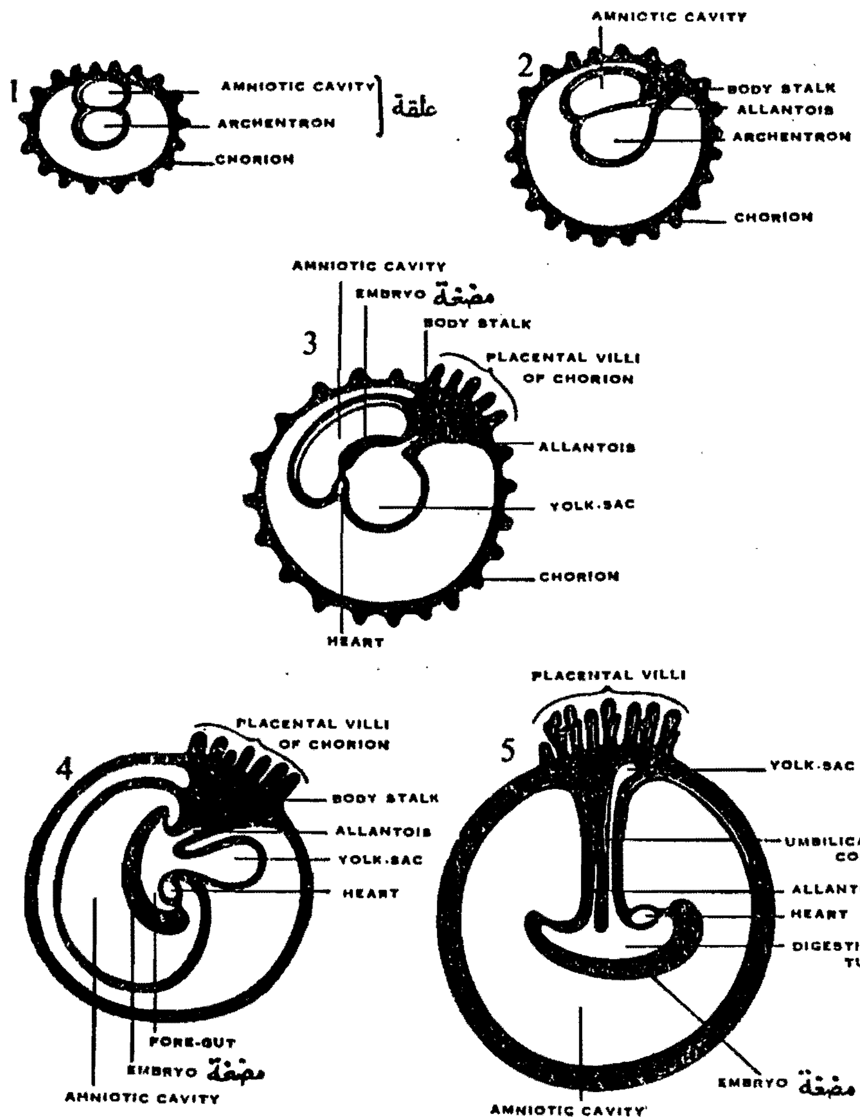


Fig. 60.--THE DEVELOPMENT AND ROLE OF EXTRAEMBRYONIC MEMBRANES IN MAN (diagramatic).

(1) Earliest observed stage of a fertilised human ovum (blastocyst). The hanging mass inside the blastocyst is (علقة).

(2) Early formation of Allantois.

(3) Embryo (مضغة) makes its appearance inside the (علقة).

(4) The amniotic cavity expands and the umbilicus begins to form. 'Muzgha' more prominent.

(5) The functions of yolk-sac (food supply) and allantois (excretion) are taken up by the placenta.

It may be interesting to note that the human embryo lying inside the amniotic pool behaves like an aquatic animal. If we soak our own hand in water for some time the skin assumes a puckered appearance, but the fetus keeps lying inside the water for months together without any effect on its skin. In the early stages the faetal skin is covered by a single layer of cells. Later it becomes double and the superficial layer forms what we call Epitrichium. About the eighth month of intra-uterine life the epitrichium is cast off, mixed with greese from skin glands and delicate hairs known as Lunago. This soapy stuff called Vernix Caseosa is conspicuous on the skin of a newly born child and gets washed off on first bath. The Epitrichium, on the other hand, persists on the body of frog and other aquatic animals after hatching and thus protects their skin from maceration in later life. This similarity points towards the origin of man from the aquatic ancestors. The Holy Quran says:

(21:30) ... وَجَعَلْنَا مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ ...

"We made from water everything living."

(25:54) وَهُوَ الَّذِي خَلَقَ مِنَ الْمَاءِ بَشَرًا ...

"It is He Who created man from water."

THE DEVELOPMENT OF EMBRYO

"The student of Nature wonders the more and is astonished the less, the more conversant he becomes with her operations; but of all the perennial miracles she offers to his inspection, perhaps the most worthy of admiration is the development of a plant or animal from its embryo." (HUXLEY)

Above described are the changes that occur in the outer cells of the blastocyst. Now let us describe the changes in the inner cell mass. Two processes, essentially distinct, though intimately associated with each other are responsible for the transformation of a zygote into the complex form of a newly born child. These are growth and differentiation. The inner cell mass of blastocyst gets arranged into two layers; *Ectoderm* or outer layer, and *Endoderm* or inner layer. A third layer *Mesoderm* or intermediate layer later makes its appearance. Cells get differentiated and specialised in all the three layers; and different tissues, organs and organ systems, thus come into existence. Three weeks after fertilisation the human embryo is about the size of a coarse grain of sand, some three quarters of it consisting of head structure. Four weeks after fertilisation, the eyes are partly developed and the heart is already beating. Limb buds appear in the fifth week, ears become conspicuous at that time and the embryo now responds to mechanical stimulii. Human form is recognisable eight weeks after fertilisation when the embryo is called a *Fetus*. By the twelfth week, the semicircular canals in the ears are functional and the fetus moves of its own accord within the amniotic pool. Eye lids are still fused but eye balls may move underneath. Five months after fertilisation the fetus is about eight inch long and weighs about one lb. and the facial features show signs of individual personality.

The Holy Quran describes the different stages of embryonic development in its own sublime way. In the early stage of development the hanging mass inside the blastocyst is termed by the Holy Quran as '*Alaqa*'. This is evident from Fig. 60.

The next stage where further differentiation of cells has taken place and the embryo becomes conspicuous with the development of tissues and organs, it is described as *Muzgha*. Figs. 60 and 61 show different stages of *Muzgha* (Embryo). Still later when the development of fetus has reached a stage at which the process of differentiation becomes so complicated that it is no longer possible to describe an embryo as a whole, the Holy Quran points towards different systems, such as skeletal system (Fig. 62a), and muscular system (Fig. 62b), these two forming the bulk of the body.

The following verse shall make it clear:

وَلَقَدْ خَلَقْنَا الْإِنْسَانَ مِنْ سُلَالَةٍ مِنْ طِينٍ ۝ ثُمَّ جَعَلْنَاهُ نُطْفَةً فِي قَرَارٍ مَكِينٍ ۝
ثُمَّ خَلَقْنَا النُّطْفَةَ عَلَقَةً فَخَلَقْنَا الْعَلَقَةَ مُضْغَةً فَخَلَقْنَا الْمُضْغَةَ عِظَامًا
فَكَسَوْنَا الْعِظَامَ لَحْمًا ثُمَّ أَنْشَأْنَاهُ خَلْقًا آخَرَ فَتَبَارَكَ اللَّهُ أَحْسَنُ الْخَالِقِينَ ۝ (23:12-14)

> "We created man from the extracts of clay. Then We placed him as a reproductive unit in its temporary abode, to be firmly fixed. From this reproductive unit We created '*Alaqa*' (a hanging mass). Then We created (inside) the '*Alaqa*' a '*Muzgha*'. Then We created the skeletal system (inside) the '*Muzgha*'. Then We covered the bony framework with flesh (or soft parts). Then We brought him forward as a new creation. So blessed be Allah Whose creation is most proportionate."

It may be pointed out that there is no hard and fast line between the different stages described above. One stage gradually merges into the other. The '*Muzgha*' gradually becomes differentiated within the '*Alaqa*'. On the other hand, the bones and muscles gradually become differentiated inside the '*Muzgha*'.

It is interesting to note that none of our commentators who were and are, laymen, have been able to interpret these verses of the Quran correctly. For example, the word '*Alaqa*' is generally interpreted as 'congealed blood', although there is no blood present in the embryo at this early stage, it is just a mass of undifferentiated cells. Moreover, the word '*Alaqa*' means a 'hanging object attached to something higher up.' Again, the words '*Muzgha*' and '*Lahm*' are both interpreted as "piece of flesh". They have not been able to differentiate between the different stages of development of Embryo. But, just imagine, how beautifully the evolutionary stages of embryonic development were described 1400 years ago by one (PBUH) who did not know reading and writing.

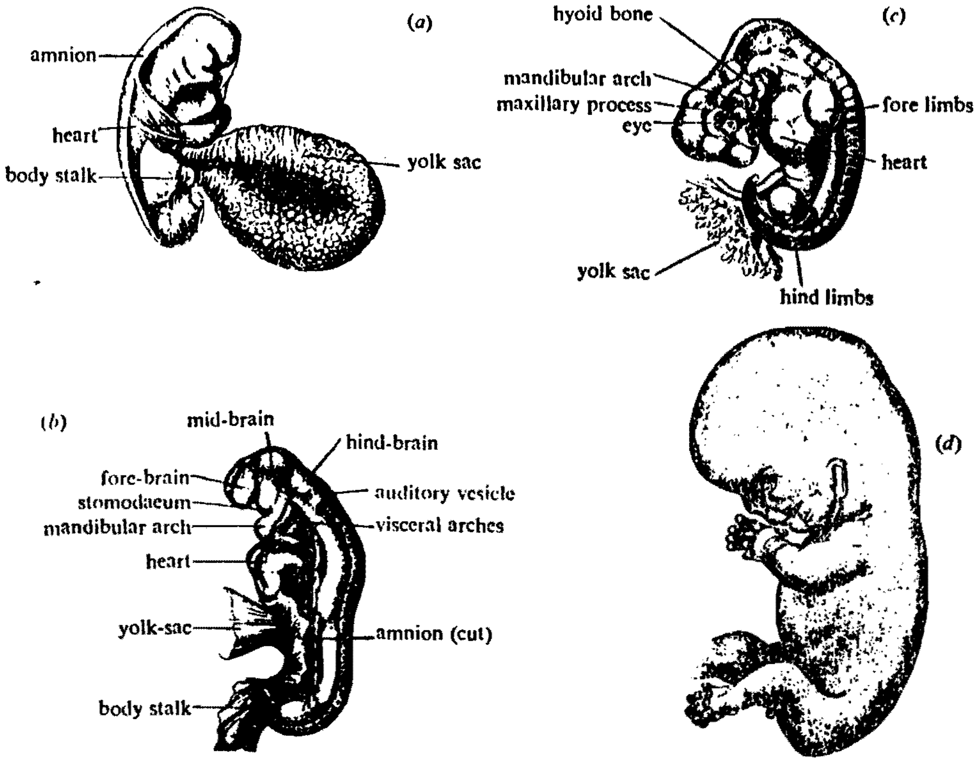


Fig.61.--A HUMAN EMBRYO (different stages of development).
(*a*) embryo 2.6 mm long. **(*b*) embryo 18-21 days old.**
(*c*) embryo 31-34 days old. **(*d*) embryo about 6 weeks old.**

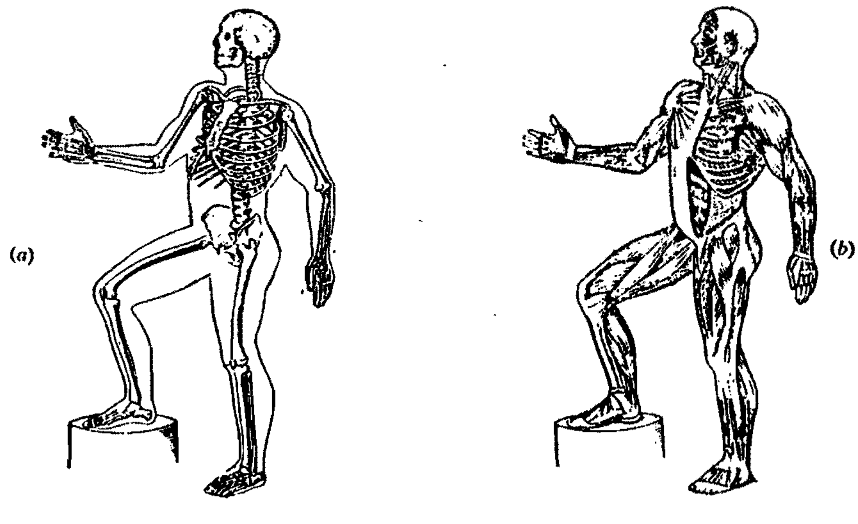


Fig. 62.--(*a*) SKELETAL SYSTEM عظماً **(in adult man).**

(*b*) FELSH OR SOFT PARTS SUCH AS MUSCLES AND FAT لحماً

We noted above that the origin of man or any other mammal, from the aquatic ancestors, is indicated by the presence of amniotic pool in which the embryo lies. We also noted that the extraembryonic membranes are an evolutionary reminder of the reptilian ancestry. The embryonic stages of animals belonging to a class or even to a phylum present remarkable resemblance to one another. The nearaer the two animals are to each other in their evolutionary history, the closer and longer is the similarity in their developmental stages. For example the embryo of man and of rabbit resemble each other till relatively late in development, before the developmental paths diverge (Fig. 63). On the other hand the embryos of man and fish are similar for considerably shorter period: here the developmental paths diverged much earlier. It may be pointed out, however, that when we say that human embryo resembles those of fish and rabbit in certain respects, it does not mean that an egg of man becomes a fish embryo first, changes to rabbit embryo next and becomes a human embryo last. The similarities are due to the common ancestry of fish, rabbit and man. Each of the three animals has inherited certain commmon characteristics from an early vertebrate ancestor. Beyond this each type has modified the general processes in its own specific way. Thus any similarities that are left are the incidental remains of common heritage.

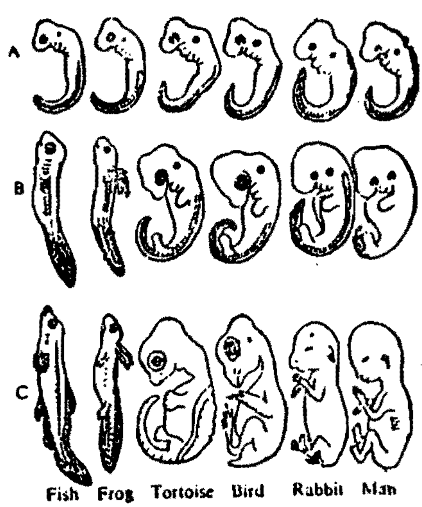


Fig. 63.—VERTEBRATE EMBRYOS.
Three stages of development.
Stage A—All embryos almost alike.
Stage B—Embryos differentiated to a certain extent.
Stage C—Species are recognisable.

These evolutionary indicators inside the embryo are referred to in the Holy Quran as follows:

... يَخْلُقُكُمْ فِي بُطُونِ أُمَّهَٰتِكُمْ خَلْقًا مِّنۢ بَعْدِ خَلْقٍ فِي ظُلُمَٰتٍ ثَلَٰثٍ ... (39:6)

> "He creates you in the wombs of your mothers, one creation after another, in three veils of darkness."

The three veils of darkness are (a) Abdominal wall (b) Uterine wall and (c) the Extraembryonic membranes. The Quran does not say three layers but three veils of darkness or three opacities. Because layers there are so many; the abdominal wall has got its own layers, the uterine wall has got its own layers and so on. As an alternative explanation, chorion, amnion and amniotic fluid may be described as three separate layers but individually they are not opaque.

Rabubiyyat (Provision of sustenance). The early nutritional evolution, as well as the various ways of providing the means of sustenance to living creatures by the Creator of the universe, have been described earlier, in different contexts. In Chapter VI were explained the different methods of procuring food, by the early cell types, that evolved after the nutrients, in the ocean water, become inadequate for the maintenance of life. On the other hand while describing the honeybee society, in Chapter VIII, it was mentioned as to how the social ranks amongst the bee get their subsistence in a unique and regular pattern. In Chapter IX has been described the barrier or برزخ between the two segments of global water cycle عذب فرات (sweet and palatable fresh-water) and ملح اجاج (intensely bitter salt-water), as a glorious manifestation of Allah's Rabubiyyat. But for this barrier the maintenance of fresh-water supply and consequently the maintenance of higher forms of life on the land could not continue any longer.

Here again we find another remarkable link in the chain of Allah's 'Rabubiyyat'. We noted earlier in this chapter that fish and amphibia lay eggs inside the natural bodies of water. The eggs are in direct contact with water which is the source of their nourishment. There is no danger of drying up either. The eggs are thus without any protective shell. In reptiles and birds on the other hand, the egg needs protection against desiccation and physical shock. hence it is protected by shell, and the amniotic fluid has developed as a shock absorber. As long as the embryo remains within the shell it is not capable of obtaining food from outside. Hence a big store of yolk within the egg itself. The shell itself is a unique specimen of Allah's creation. It allows air for respiration to pass through, yet the water is not allowed to evaporate. In mammals, the egg becomes well protected inside the uterus, thus the shell is eliminated; the nutrition and respiration are carried through mother's blood. Thus the quantity of yolk is insignificant as compared with bird's egg. It is just sufficient to sustain the embryo during the period of its journey through the fallopian tube and before it gets embedded in the uterine wall. At birth when the new born gets disconnected from the placenta, the milk food is ready in the mother's breasts.

How eloquent and befitting is the Quranic verse:

اِقْرَاْ بِاسْمِ رَبِّكَ الَّذِيْ خَلَقَ ۚ خَلَقَ الْاِنْسَانَ مِنْ عَلَقٍ ۚ (96:1-2)

"Proclaim the attribute of Rabubiyyat of thy Sustainer Who created (the universe), and created man out of 'Alaq' (A Hanging Mass)".

The verse is said to be the first ever revealed to the Holy Rasool (PBUH). It really deserved that pre-eminent position. Apart from the assertion that the Creator is the Sustainer of the entire universe, thus pointing towards the uniformity of action in the processes of creation and sustenance, the word'Alaq' is significant in its own way. It was absolutely impossible, for any human being, to imagine 1400 years ago that human life in the mother's uterus starts from 'a hanging mass' inside the blastocyst, a thing invisible to the naked eye. It could be nothing but revelation.

VIABLE AGE OF FETUS

An interesting point arises from certain verses of the holy Quran which it is worthwhile to mention at this juncture.

The Quran says:

وَالْوَالِدَاتُ يُرْضِعْنَ أَوْلَادَهُنَّ حَوْلَيْنِ كَامِلَيْنِ لِمَنْ أَرَادَ أَنْ يُتِمَّ الرَّضَاعَةَ ؕ
وَعَلَى الْمَوْلُودِ لَهُ رِزْقُهُنَّ وَكِسْوَتُهُنَّ بِالْمَعْرُوفِ ...

(2:233)

> "The mothers shall give suck to their offspring for two whole years, if the father desires to complete term, but he shall bear the cost of their food and clothing on equitable terms".

Again it said:

وَوَصَّيْنَا الْإِنْسَانَ بِوَالِدَيْهِ إِحْسَانًا ؕ حَمَلَتْهُ أُمُّهُ كُرْهًا وَّوَضَعَتْهُ كُرْهًا ؕ
وَحَمْلُهُ وَفِصٰلُهُ ثَلٰثُونَ شَهْرًا ...

(46:15)

> "We have enjoined on man kindness to his parents, in pain did his mother bear him and in pain did she give him birth. Her (Period of) gestation and weaning (is) thirty months".

At yet another place it is said:

وَوَصَّيْنَا الْإِنْسَانَ بِوَالِدَيْهِ ۚ حَمَلَتْهُ أُمُّهُ وَهْنًا عَلٰى وَهْنٍ وَّفِصٰلُهُ
فِيْ عَامَيْنِ ...

(31:14)

> "And We have enjoined on man (to be good) to his parents. In weakness upon weakness did his mother bear him and his weaning was in two years".

The commentators from amongst our orthodoxy have tried to lay down some legal points based on the above-said verses. In Tafhimul-Quran" page 610 Syed Abul Ala Madoodi has related a Hadith which runs as follows: "During the caliphate of Hazrat Osman (the III Caliph) a certain person married a woman who gave birth to a viable child six months after their marriage. The husband brought the case before the Caliph with a plea that his wife has given birth to an illegitimate child. On hearing the case, the Caliph ordered the punishment of رجم Rajam, (stoning to death) to the woman. Hazrat Ali (the IV Caliph), when he came to know of this order, approached Hazrat Osman and invited his attention to the (above said) verses 2/233, 31/14 and 46/15 which he read in succession. He clarified that with reference to verse (31:14) the period of breast feeding is 2 years (24 months) and reference verse (46:15), the period of child bearing plus the period of breast feeding is thirty months. Accordingly the period of gestation (child bearing) is 30-24=6 months. Thus, based on the above, a woman can give birth to a viable infant after 6 months pregnancy. Hence the woman in question could not be punished for adultery. On hearing this Hazrat Osman repealed his decision of the case. Syed Abul Aala Madoodi has concluded 3 legal issues from the above said verses--

"(1) A woman who gives birth to a viable child, in a period less than six months of pregnancy is a case of adultery, the inheritance, of this newly born child, from her husband shall not bear proof.

(2) A woman who gives birth to a viable child, six months or more after her marriage, can not be accused for adultery based on the birth incidence of the child; her husband can not be given the right to accuse her, nor can the husband deny the inheritance of the child from him. The baby born *shall be considered positively to be his offspring* (بچہ لازماً اسی کا مانا جائے گا) and the wife shall not be punished.

(3) The period of breast feeding is two years. If the child is breast-fed by another woman after the age of two years, that woman shall not be considered the fostered mother of the child and the laws of breast feeding (given in the Quran, including 4:23) shall not be applicable to her. (Tafheemul-Quran. Vol. 4, page 610). As a precautionary measure, Imam Abu Hanifa had fixed the period of breast feeding as $2\frac{1}{2}$ years, so as to avoid any mistake in the delicate matter of feeding. This he did on the assumption that in the case of some children, the food of child continues to be mother's milk only, even after two years, as they have not changed to other articles of food yet".

The Hadith quoted by Abul Aala Madoodi does not appear to be authentic, on account of the following reasons--(1) The punishment of 'Rajm' mentioned in this 'Hadis', is no where to be found in the Quran and Hazrat Osman could not order an un-Quranic punishment.

(2) To declare categorically that a fetus becomes viable or capable of independent existence after six months of pregnancy, is against facts. Neither the obstetricians nor the general public has ever produced an evidence in favour of it.

Let us consider the stages of development of a fetus inside the mother's uterus--leaving aside the earlier stages of development. Within five months after fertilisation as described earlier, the fetus is about 8 inches long and weighs about one lb; facial features show signs of individual personality. In the ensuing weeks, the breathing machinery develops rapidly. The fetus is now in a perpetual state of drowsiness, neither sleeping, nor waking. Overt body movements are sporadic and uneven, but important facial reflexes are being developed. True wakefulness occurs in the 8th and 9th months of pregnancy. Body fat is being laid down and the fetus acquires a sturdier stature generally. From 5 months onwards the brain sulcii gradually develop and at the 7th month all the important sulcii can be recognised. From the above description it appears that it is mainly the nervous system which is under-developed at the end of 6th months period.

"The normal period of human gestation is 280 days or 40 weeks or 10 menstrual periods. At 28 weeks the fetus weighs about 1400 grams. The subcutaneous fat is becoming more developed, so that wrinkles begin to disappear. The testicles appear in the inguinal canal. (The testes completely descend in to the scrotum at the end of 9th month). At this period the foetus is said to be viable and *the law assumes that it can survive after birth*. But the number of infants that can survive such premature birth is very small. Most infants born prematurely at or later than 36 weeks survive". (Obstetrics by Ten Teachers. 12th edition 1976).

Thus obstetricians' life long experience shows that 28 weeks is the earliest period at which a newly born infant has got the rare chance of survival. By calculation, six months of Solar calendar (1st January to 30 June, with February 29 days) make 26 weeks; and six months of Lunar calendar make 25 weeks and 2 days. Was the infant mentioned in the above said 'Hadith', quoted by Madoodi, the only infant on the face of the earth that survived after delivery at six months. I shall be grateful if somebody could produce a second instance of such an early survival, and help us in solving this dilemma. On the other hand, let us assume for a moment that there is a rare chance of survival of an infant born at 6 months' pregnancy. After all what is the sense in laying down a rule that any such baby shall be considered *positively* to be the offspring of his husband.

Let us consider in depth the verses of the Holy Quran quoted earlier i.e., 2/233, 31/14 and 46/15. We find that the verse 2/233 comes in the midst of regulations on divorce and it applies primarily to the cases of divorce where some definite law is necessary, as the father and the mother, would not, on account of divorce, be on good terms and the interest of the children must be safeguarded. The verses says, "The mother shall give suck to the child for two whole years, if the father desires to complete the term". It means that the period of two years fixed for breast feeding by the mother is conditional and dependent on the father's desire to have it done. If the father and mother by mutual agreement want to terminate breast feeding by the mother, or make some other arrangement such as artificial feeding or feeding by a wet nurse, they are allowed to do so. The verse 31:14 states, "We have enjoined on man to be good to his parents. In weakness upon weakness did his mother bear him and his weaning was in two years". The basic idea in this verse is the courtesy and kindness towards the parents, as they took pains in the nourishment and development of their offspring. The statement that his weaning was in two years, is only consistent with the physical development in the early childhood. The set of milk teeth in human child is completed at the age of two years which is therefore the natural extreme for breast feeding, although every child is not fed for full two years. Though it is beneficial for the child, every mother does not adhere strictly to this procedure and no law prohibits her to do so except under special circumstances stated in verse 2:233.

Thus two years period of breast feeding is provisional. The very fact that Imam Abu Hanifa increased it to two and a half years, shows that it can be increased or decreased according to individual requirements.

The verses (31:14) and (46:15) are not dependent one upon the other "In pain did his mother bear him and in pain did she give him birth" (46:15). "In weakness upon weakness did his mother bear him" (31:14). The question arises, do the weakness and hardships of pregnancy start from the very beginning of pregnancy? It is well known that first few months of pregnancy are not the period of hardship. The Quran also divides the period of pregnancy into two--(a) Light burden and (b) Heavy burden. Thus it is said:

هُوَ الَّذِىْ خَلَقَكُمْ مِّنْ نَّفْسٍ وَّاحِدَةٍ وَّجَعَلَ مِنْهَا زَوْجَهَا لِيَسْكُنَ اِلَيْهَا ۚ فَلَمَّا
تَغَشّٰهَا حَمَلَتْ حَمْلًا خَفِيْفًا فَمَرَّتْ بِهٖ ۚ فَلَمَّآ اَثْقَلَتْ دَّعَوَا اللّٰهَ رَبَّهُمَا
(7:189) لَىِٕنْ اٰتَيْتَنَا صَالِحًا لَّنَكُوْنَنَّ مِنَ الشّٰكِرِيْنَ ۝

> "It is He Who created you from a single life cell and from it made its mate, in order that he might dwell with her. When they are united, she bears a light burden and carries it about un-noticed. When she grows heavy, they both pray to their 'Rabb' (saying)-- If thou give us a 'saleh' child we shall be grateful".

Thus the hardships of pregnancy start in the later months of pregnancy when the mother becomes heavy. Consequently "thirty months" mentioned in the verse (46:15) include the later 6 months of pregnancy which is a period of weakness and hardships plus the 24 months of breast feeding.

CHAPTER XIII

Self-Perpetuation: Adaptation

HEREDITY

وَفِي الْأَرْضِ قِطَعٌ مُتَجَاوِرَاتٌ وَجَنَّاتٌ مِنْ أَعْنَابٍ وَزَرْعٌ وَنَخِيلٌ صِنْوَانٌ وَ
غَيْرُ صِنْوَانٍ يُسْقَىٰ بِمَاءٍ وَاحِدٍ وَنُفَضِّلُ بَعْضَهَا عَلَىٰ بَعْضٍ فِي الْأُكُلِ إِنَّ
(13:4) فِي ذَٰلِكَ لَآيَاتٍ لِقَوْمٍ يَعْقِلُونَ ۝

"And in the earth are adjacent tracts, vineyards, agricultural land, date-palms growing out of a single root or otherwise: watered from the same water, yet We make one superior to the other in eating. Verily in it there are Signs for those who reflect."

Every organism is adapted to its environments structurally as well as functionally. Fish is an aquatic animal well suited for swimming. Most of the reptiles are land animals suited for walking or crawling. Bird is an aerial animal suited for flying. Yet the ancestry of bird traces through reptiles to fish. Over long periods of time the organisms adapt themselves to new environments. Thus adaptation is a long-range process of development. It consists of three components-*sex*, *heredity* and *evolution*. We have already discussed the adaptive role of sex in the last chapter and we now take up heredity.

HEREDITY

Heredity is resemblance based on descent; the occurence in living organisms of qualities expressed or hidden that are derived from ancestors. It includes physical and physiological characteristics, instincts and even psychological features in higher animals and man. Differences among individuals of a species are called *Variations*. But actually the qualities or traits are not inherited. It is the reproductive unit containing the parent genes (نفس واحدة) that is inherited. Visible traits appear under the influence of genes, within limits of intercellular and extracellular environments. Genes are hidden and traits are manifest. We therefore learn the heredity of genes from the manifest resemblances and variations.

The person who first made decisive experiments in heredity and formulated basic laws which laid the foundation of the science of genetics, was Gregor Johann Mendel (Fig.71).

His work was published in 1865. Mendel noticed in the pea plant seven pairs of contrasting characters, three of which are as follows:

(1) Length of the stem-tall or dwarf.
(2) Seed shape-smooth or wrinkled.
(3) Colour of seeds-yellow or green.

On the basis of his experiments on contrasting characters, he formulated two laws:-

(1) Law of segregation or purity of gametes.
(2) Law of independent assortment.

Law of Segregation of Gametes. This means that the genes representing a pair of contrasting traits, when brought together by the union of two gametes, co-exist in the cells of the offspring, and later become separated in the gametes, so that each male or female gamete carries only one gene for a member of the pair but never both. The following shall illustrate:--

(Fig.64). If a pair of red-flowered Four O'clocks (*Mirabilis Jalapa*) are mated, the colour of all the offspring produced shall be red through successive generations.

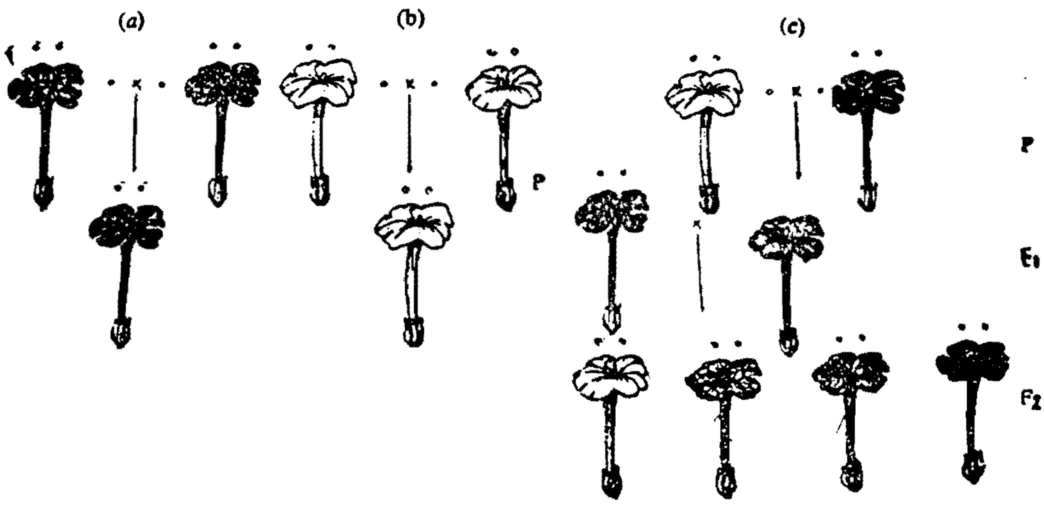


Fig. 64.--HEREDITY.

P = Parents. F_1 = Offspinrg's first generation.
F_2 = Offspring's second generation.
(*a*) Red-flowered plants mated with red-Offspring of successive generations RED.
(*b*) White-flowered plants mated with white-Offspring of successive generations WHITE.
(c) White-flowered plants mated with red-Offspring of first generation (F_1) all PINK.
Pink-flowered plants (F_2) mated with each other-Offspring of second generation (F_2) are:-
WHITE 25% PINK 50% and RED 25%.

Similarly if a pair of white-flowered plants are mated, the offspring shall be all white-flowered and the later generations shall also be white-flowered. Red and white colours in these cases are true breeding.

On the other hand, if a red Four O'clock is mated with a white-flowered plant, all offspring in F_1-First Generation developed pink flowers. Pinkness here is not true breeding. It is not a permanent blend of red and white. It is not like red and white paints producing pink paint when mixed together. Because if pinkness were true breeding, the two pink-flowered plants mated together would have produced pink offspring. But actually the results are quite different. A pair of pink-flowered plants mated together would produce three different types of offspring in F2-Second Generation:- Of these about 50% are pink, 25% red and 25% white.

The above phenomena may be explained as follows:- A true breeding red-flowered plant possesses a pair of red pigment-producing genes in each cell. Letters AA in Fig. 65a represent these genes which are located on a pair of chromosomes one of which is maternal and one paternal in origin. We may say that the *Genotype* (gene content) of the plant is AA and the *Phenotype* (visible appearance) is red.

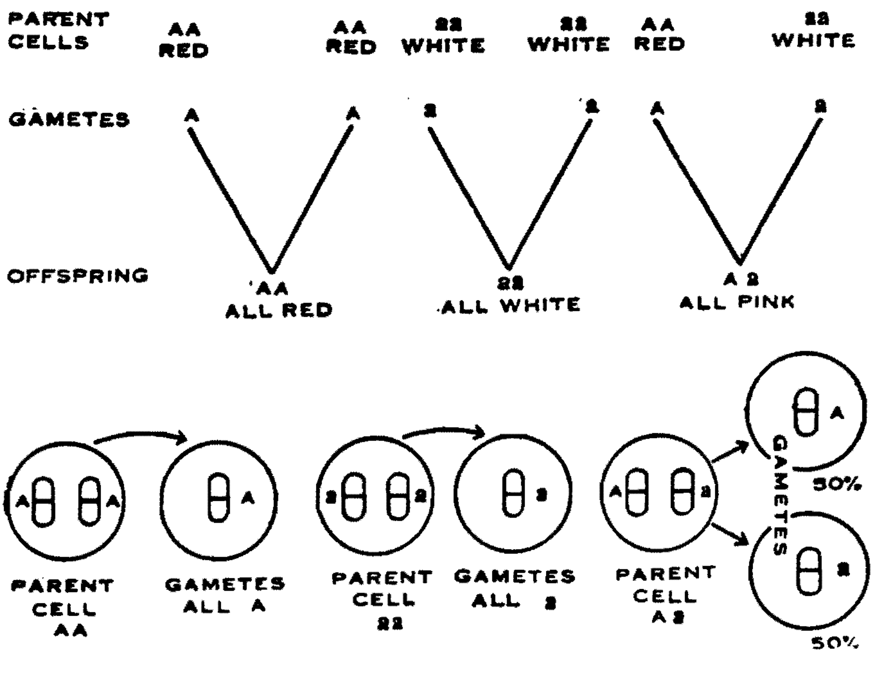


Fig.65a.--Transmission of genes. Explanation of results produced by mating flowers-Red X Red, White X White and Red X White. Red pairs of genes are symbolised as AA, White pairs as aa and Pink pairs as Aa.

Meiosis occurs before the production of gametes. Mature gametes therefore contain only one of the two chromosomes, hence only one of the two genes. It is a matter of chance which of the two adult chromosomes will pass into a given gamete. Since both adult chromosomes here carry the same colour gene, all gametes will be generally similar. That is why the mating of red-flowered plants (AA+AA) will produce (AA) red-flowered offspring.

Same is the case with white-flowered plants. Letters aa in the illustration represent the genotype of a true breeding white-flowered Four O'clock which does not produce any pigment. A mating of two such plants will produce only white-flowered offspring.

On the other hand if a red-flowered and a white-flowered plants are mated, all offspring will be pink. Here an Aa offspring plant possesses only one pigment producing gene per cell. Such a cell produces only half as much pigment as an AA cell which contains two pigment-producing genes. Thus the colour AA is dilute red or pink.

If now a pair of Aa plants (pink) are mated (Fig. 65b), after meiosis the two genes segregate or separate and half of the gametes receive the gene 'A' and the other half the gene 'a'. Thus each gamete carried 'A' or 'a' but not both. In other words a gamete is pure with respect to one or other member of the pair of the contrasting traits.

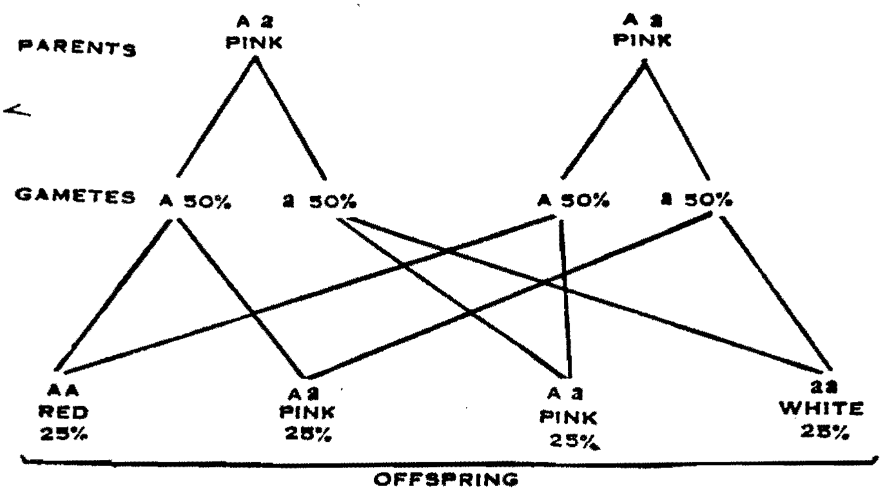


Fig. 65b.--Explanation of results produced by mating flowers -- Pink X Pink.

After fertilisation there are two genetically different egg types and two genetically different sperm types and it is a matter of chance which of the two sperm types fertilise which of the two egg types. If many fertilisations occur simultaneously, all possibilities will be realised with appropriate frequency. As a result half the offspring shall be pink, like their parents; 25% red and 25% white, and these offspring resemble their grand parents.

This shows clearly that the genes representing the traits red and white when brought together by the union of two gametes do not blend with each other but co-exist in the cells of the offspring and later became segregated in the gametes.

The same formula applies to variations in colours amongst animals. For example mating a pair of birds of a species one black and one white, the pattern of inheritance shall be according to the law of segregation described above. The Holy Quran says:

وَمَا ذَرَأَ لَكُمْ فِي الْأَرْضِ مُخْتَلِفًا أَلْوَانُهُ إِنَّ فِي ذَٰلِكَ
(16:13) لَآيَةً لِّقَوْمٍ يَذَّكَّرُونَ ه

"And the things of multiple colours that He has created for you on this earth, in them there is a sign for those who keep the working of the Divine laws before them."

Genetic Dominance. Genes which control the same trait but produce different expressions of that trait are called *Alleles*. For example, the shape of a garden pea may be round or wrinkled. Thus the genes controlling the round shape and the wrinkled shape are allelic genes or alleles. Out of these two types, those controlling the round shape are called *Dominant* alleles and those controlling the wrinkled shape are called *Recessive* alleles, because if mated together the round completely mask the effect of wrinkled and the resulting offspring is round.

(6:99) ... مُشْتَبِهًا وَغَيْرَ مُتَشَابِهٍ ...

"(*Fruits*) similar in kind and yet different in variety."

Law of Independent Assortment. This law states that the inheritance of a gene pair located on a given chromosome is unaffected by the simultaneous inheritance of other gene pairs located on other chromosome pairs. In other words two or more traits produced by genes located on two or more chromosome pairs assort independently, i.e., each trait will be expressed independent of other traits.

Mendel crossed a variety of pea having round-yellow seeds (both dominant characters) with one having wrinkled-green seeds (both recessive characters). The seed shapes obtained from these two pure forms were all round-yellow, i.e., they showed both dominant characters. When the hybrid* plants of the first generation produced by these two seeds were self-fertilised they produced in the second generation four types of seeds :-(1) Round yellow 56.7%, (2) Wrinkled yellow 18.2%, (3) Round green 19.4% and (4) Wrinkled green 5.7%.

*Offspring from two different types of parents (دوغلہ).

The results obtained from the above experiments may be explained as follows:- Let the dominant round shape be symbolised as R, wrinkled shaped as r, yellow colour as Y and green colour as y. The gametes of round-yellow parent will

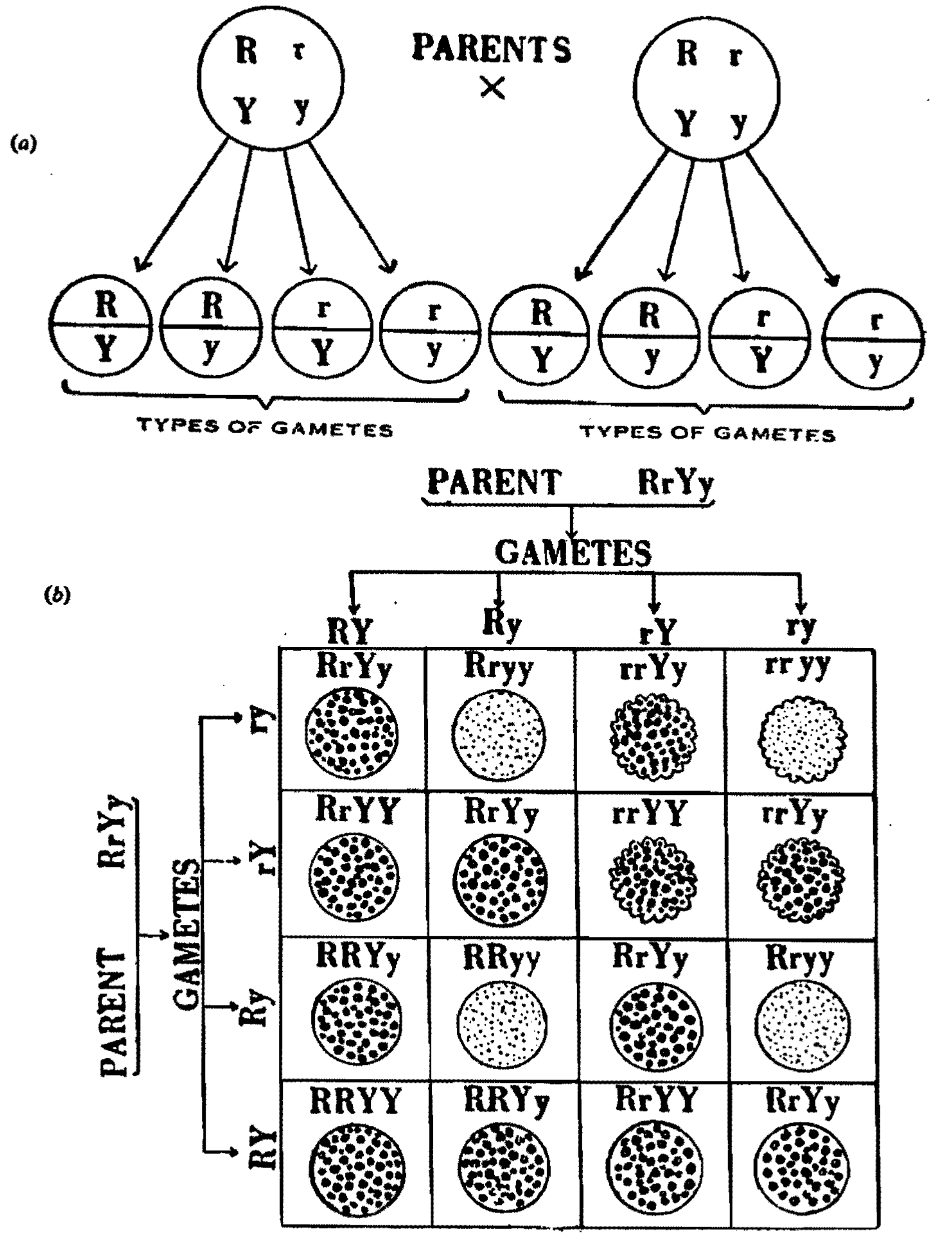


Fig. 66.--LAW OF INDEPENDENT ASSORTMENT.

carry the genes RY and those of the wrinkled-green as ry. The zygote formed by the union of two such gametes will carry Rr Yy genes and will give rise to offspring with round yellow seeds. Now when a hybrid arising from the zygote forms its gametes, the members of each trait-producing pair of genes behave independently of those of the other pair. That is a gamete bearing a gene for the roundness of the seed, may also bear a gene for yellow or green colour. Similarly a gamete bearing a gene for wrinkledness may also bear a gene for yellow or green colour. Thus there will be four kinds of male gametes and four kinds of female gametes; and the four kinds in each case will be RY,Ry,rY,ry (Fig.66a). On fertilisation any one of the four male gametes will unite with any one of the four female gametes and hence there will be sixteen possible combinations as shown in (Fig.66b).

If in accordance with the phenomenon of dominance 'r' is recessive allele when it meets the allele 'R', and 'y' is the recessive allele when it meets the allele 'Y', we will get the proportion of:-

Round yellow-9, 56.7% Round green-3, 19.4% Wrinkled yellow-3, 18.2%
Wrinkled, green-1, 5.7% (Fig. 67).

It is interesting to note here that Total Round seeded offspring are 56.7 + 19.4= 76.1%; and Total wrinkled seeded offspring are 18.2 + 5.7 = 23.9%. Thus the ratio of round and wrinkled is 76.1 to 23.9, i.e. approximately 3 : 1. Again total of yellow coloured offspring are 56.7 + 18.2 = 74.9 : and Total of green coloured offspring are 19.4 + 5.7 = 25.1. Thus the ratio of yellow and green is 74.9 to 25.1, i.e., approximately 3:1. In other words, each of the two dominant traits considered separately amounted to very nearly 75% and each of the two recessive traits considered separately amounted to about 25%, of the total.

Moreover, the two dominants, even if they are considered together, are also three times as abundant. It means that out of the 76.1% of total round-seeded offspring 56.7% or nearly three-fourth are at the same time yellow-seeded; and among the 74.9% total of yellow-seeded offspring 56.7% or nearly three-fourth are again round-seeded.

Mendel concluded that such a ratio could be obtained only if each trait obeyed the law of segregation and if it were therefore expressed independently of other traits. Hence this law of Independent Assortment.

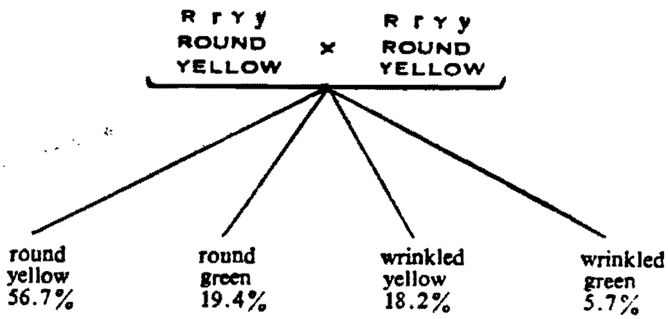


Fig. 67.-MATING OF HYBRID ROUND-YELLOW SEEDS OF FIRST GENERATION. (parents matured from seeds of Rr Yy type)

We thus realise how in nature the same kind of product appears in different varieties. The Holy Quran refers to this fact as follows:

وَهُوَ الَّذِيْٓ اَنْزَلَ مِنَ السَّمَآءِ مَآءً ۚ فَاَخْرَجْنَا بِهٖ نَبَاتَ كُلِّ شَيْءٍ فَاَخْرَجْنَا مِنْهُ
خَضِرًا نُّخْرِجُ مِنْهُ حَبًّا مُّتَرَاكِبًا ۚ وَمِنَ النَّخْلِ مِنْ طَلْعِهَا قِنْوَانٌ دَانِيَةٌ وَّ
جَنّٰتٍ مِّنْ اَعْنَابٍ وَّالزَّيْتُوْنَ وَالرُّمَّانَ مُشْتَبِهًا وَّغَيْرَ مُتَشَابِهٍ ۗ اُنْظُرُوْٓا
اِلٰى ثَمَرِهٖٓ اِذَآ اَثْمَرَ وَيَنْعِهٖ ۗ اِنَّ فِيْ ذٰلِكُمْ لَاٰيٰتٍ لِّقَوْمٍ يُّؤْمِنُوْنَ ۝ (6: 99)

> "It is He Who sends down (according to His law) rain from above. And He says that with it We produce vegetation of all kinds. We produce from it green buds, from which We bring forth the thick clustered grain; and (We bring forth) gardens of grapes, and the olives and pomegranates: *Each similar in kind and yet different in variety*. Look upon the fruit thereof, when they bear fruit and upon its ripening. Herein verily are Signs for a people who believe."

The law of independent assortment applies specifically to gene pairs located on different chromosome pairs. The law will therefore hold for as many different gene pairs as there are chromosome pairs in each cell of a given organism. We noted above, that a double heterozygote Aa Bb produces four different gamete types. Thus a triple heterozygote Aa Bb Cc would produce eight different gamete types, namely ABC, ABc, AbC, Abc, aBC, aBc, abC, and abc. Thus 8 male types of gametes crossing with 8 female types will result in 64 offspring types. Of these sixty-four types 27 will express 3 traits in dominant form. The complete phenotype ratio will be 27:9:9:9:3:3:3:1. Similarly a quadruple heterozygote AaBbCcDd would manufacture 16 gamete types each and after mating 256 different offspring types will result. Evidently the offspring shall multiply to an enormous number if we consider more than a few traits simultaneously.

In man there are 23 pairs of chromosomes per cell. Consequently Mendel's law of independent assortment will apply to any 23 different traits controlled by genes located on different chromosome pairs. We have seen that a monohybrid yields 2 gamete types, a dihybrid 4 gamete types and a trihybrid 8 gamete types. Carrying it further we find that a 23-fold hybrid will produce 2^{23} or over 8 million genetically different gamete types. Therefore in considering just 23 traits we would require a grid 8 million by 8 million to represent the over 64 trillion possible genotypes.

A particular individual then inherits just one of these genotypes. Of all the possible genotypes, a few millions or billions will produce resemblance to parents and another few millions or billions to grand parents or earlier ancestors. But there are bound to be a good many million or billion geno types which have never yet become expressed during the entire history of mankind. That is why any two newly born human individuals are never alike in appearance.

The Holy Quran says:

(7:11) وَلَقَدْ خَلَقْنٰكُمْ ثُمَّ صَوَّرْنٰكُمْ ...

"We indeed created you and gave you features (so that one could be distinguished from the other)."

We may conclude from what has been described above that the creation, of all the different types of animals and plants that exist on the earth, is gene-controlled and the variation in different types has occurred through mutation and sex. Only a date-palm shall grow from a date-stone and a grape plant from a grape-seed. On the other hand one fruit is superior to the other in eating though both of them may be grown in the same tract of land and watered from a common source. The Holy Quran repeatedly refers to this phenomenon, and appeals to the human intellect and deep thinking:

وَفِي الْاَرْضِ قِطَعٌ مُّتَجٰوِرٰتٌ وَّجَنّٰتٌ مِّنْ اَعْنَابٍ وَّزَرْعٌ وَّنَخِيْلٌ صِنْوَانٌ
وَّغَيْرُ صِنْوَانٍ يُّسْقٰى بِمَآءٍ وَّاحِدٍ وَنُفَضِّلُ بَعْضَهَا عَلٰى بَعْضٍ فِي الْاُكُلِ
(13:4) اِنَّ فِيْ ذٰلِكَ لَاٰيٰتٍ لِّقَوْمٍ يَّعْقِلُوْنَ ۝

"And in the earth are adjacent tracts, vineyards, agricultural land, date-palms growing out of a single root or otherwise: watered from the same water, yet We make one superior to the other in eating. In it there are signs for those who reflect."

يُنْۢبِتُ لَكُمْ بِهِ الزَّرْعَ وَالزَّيْتُوْنَ وَالنَّخِيْلَ وَالْاَعْنَابَ وَمِنْ كُلِّ الثَّمَرٰتِ
(16:11) اِنَّ فِيْ ذٰلِكَ لَاٰيَةً لِّقَوْمٍ يَّتَفَكَّرُوْنَ ۝

"With it (rain) He causes to produce for you corn, olives, date-palms, grapes and every kind of fruit. Verily in this is a sign for those with deep thinking."

(15:19) وَالْاَرْضَ مَدَدْنٰهَا وَاَلْقَيْنَا فِيْهَا رَوَاسِيَ وَاَنْۢبَتْنَا فِيْهَا مِنْ كُلِّ شَيْءٍ مَّوْزُوْنٍ ۝

"And the earth We have spread out and have placed therein mountains and caused each appropriate thing to grow therein."

وَالْاَرْضَ وَضَعَهَا لِلْاَنَامِ ۝ فِيْهَا فَاكِهَةٌ وَّالنَّخْلُ ذَاتُ الْاَكْمَامِ ۝ وَ
(55:10-13) الْحَبُّ ذُو الْعَصْفِ وَالرَّيْحَانُ ۝ فَبِاَيِّ اٰلَآءِ رَبِّكُمَا تُكَذِّبٰنِ ۝

"It is He Who spread out the earth for His creatures. Therein is fruit and date-palms having sheathed clusters. Also grain with its husk and sweet smelling flowers. Then which of the bounties of your Sustainer will you deny."

The variations in offspring may occur by factors other than those governed by Mendel's two laws described above.

Inheritance of Sex. So far We have considered the two members of each pair of homologous chromosomes to be exactly alike but in the males of many species including man, the members of one of the pairs are dissimilar. One known as Y-chromosome is often smaller than its mate which is known as X-chromosome (Fig.68a). The X and Y are called sex chromosomes in contrast to all other chromosomes called Autosomes. The X chromosome of male is similar to the X-chromosome of female. Thus the female has one pair of X-chromosomes and the male has one X-chromosome and one Y-chromosome as its mate.

Fig. 68a.—X AND Y CHROMOSOMES.

In man the normal human chromosome complement consists of 44 non-sex chromosomes or autosomes and two sex chromosomes paired as XX or XY, as shown below:-

22 Autosomes		
A A A A A A A A A A A A A A A A A A A A A A	X	NORMAL MALE
		CHROMOSOME
A A A A A A A A A A A A A A A A A A A A A A	Y	COMPLEMENT
22 Autosomes		
A A A A A A A A A A A A A A A A A A A A A A	X	NORMAL FEMALE
		CHROMOSOME
A A A A A A A A A A A A A A A A A A A A A A	X	COMPLEMENT

The X-chromosome has become identified with femaleness. It would be more accurate to identify it specifically with the development of ovaries from the primitive gonadal ridge of the early embryo and with the continuation of their normal maturation into adult life. Gene loci of importance to ovarian maturation are scattered along the length of X-chromosome. Male determiners or, more accurately, testes- promoting gene loci are highly concentrated in the small Y-chromosome.

The premature germ cells in a human ovary contain 44A + XX chromosomes each and after meiosis each egg cell contains 22A+X chromosomes. The premature germ cells in male testicle contain 44A+XY chromosomes each and after meiosis produce two different kinds of sperm cells, namely 22A+X and 22A +Y, in roughly equal numbers. Fertilisation now occurs at random, i.e., a sperm of either type may unite with an egg. Therefore in about 50% of the cases the result will be (22A+X)+(22A+X) or 44A+XX or female producing zygote. In the remaining 50% of the cases, the zygote will be (22A+X) + (22A+Y) or 44A+XY or male producing zygote (Fig. 68b).

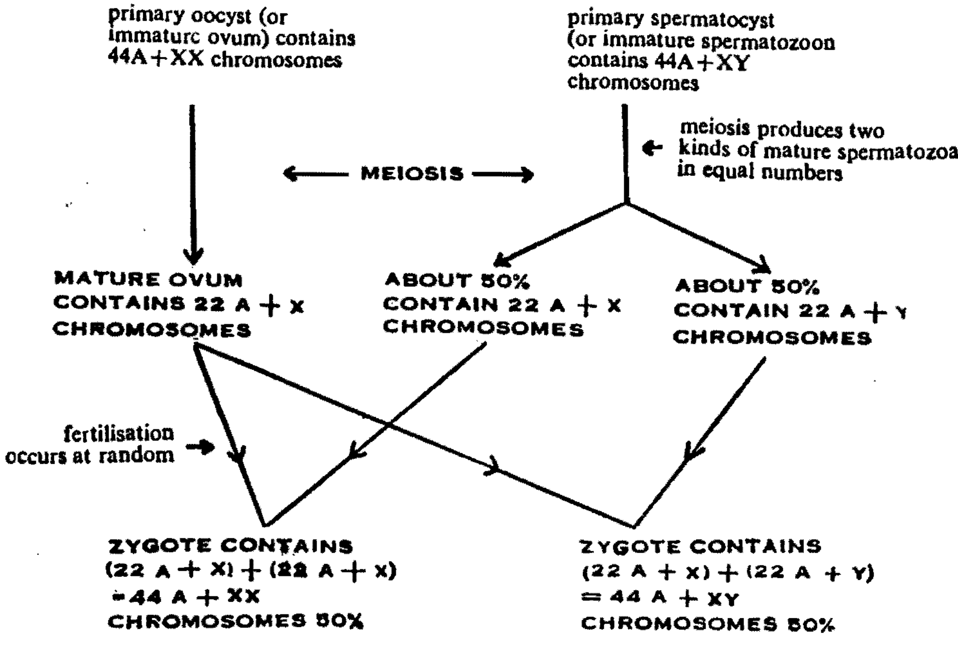


Fig. 68b--SEX DETERMINATION IN MAN.

Cytogenic studies show that testes develop in the embryo even when a Y-chromosome is obliged to compete with as many as four X-chromosomes. The role of X and Y chromosomes is concerned primarily with gonadal differentiation. Once testes have appeared in the embryo under the influence of Y-chromosome, further masculinisation of the genital system is brought about by an evocator produced by the embryonic testes. In the absence of testes the genital system develops in the female direction, without significant ovarian influence.

Any abnormality in the XX or XY chromosome complex affects the sexual characteristics of the offspring. Only recently have the scientists definitely established a relationship between odd looking chromosomes and some of the hereditary imperfections, known as Genetic diseases. The following example shall make it clear:- The more frequent abnormalities are either an XO abnormality, i.e., one X chromosome of the XX complex is absent, called X-monosomy. Or there may be an XXY abnormality, i.e. an extra X chromosome in the XY complex. A great majority of pregnancies with X-monosomy shall result in abortion in the first three months. Therefore the incidence of new-borns with this error is low-1 in 2500 live births. Such a newborn shall have lymphedema (swelling) of the legs, excessive looseness at the back of the neck, shortness of stature, congenital heart defects and skeletal anomalies. On the other hand in pregnancies with XXY complex the newborn shall be a normal male child at birth but at puberty the seminiferous epithelium has little chance of normal proliferation and spermatogenesis. The result is small and sterile testes with inability to produce offspring. Moreover there shall.be 1:4 risk of mental retardation. The above points have been mentioned brifely in order to bring into light the laws governing the sex formation.*

The Holy Quran says:

لِلّٰهِ مُلْكُ السَّمٰوٰتِ وَالْاَرْضِ يَخْلُقُ مَا يَشَآءُ يَهَبُ لِمَنْ يَشَآءُ اِنَاثًا
وَّيَهَبُ لِمَنْ يَشَآءُ الذُّكُوْرَ ۝ اَوْ يُزَوِّجُهُمْ ذُكْرَانًا وَّاِنَاثًا وَيَجْعَلُ
مَنْ يَشَآءُ عَقِيْمًا اِنَّهٗ عَلِيْمٌ قَدِيْرٌ ۝ (42:49-50)

The usual translation of the above verses is as follows:

> "To Allah belongs the dominion of the Heavens and the Earth. He creates what He wills. He bestows (children) male or female according to His will. Or He bestows both males and females, and He leaves barren whom He will. For He is full of knowledge and power."

*It may not be out of place to mention here that experiments are already underway to devise means of altering the structure of chromosomes of animals, in order to change their characteristics and in the near future parents may be able to choose the sex of their children. Only recently Dr. Ott, Director of Environmental Health and Light Institute at Sarasota has pointed out that artificial light can be used to influence and even change the sexual development of man and other animals. According to him, the light changes the chemical balance of the body through its effect on endocrine system. It affects the Pituitary and other glands through the eyes. Artificial blue light has already been put to use to increase the number of females in litres, and in this way the ratio has been changed to 80-20 in favour of females. On the other hand, pinkish light is used to increase the number of male babies. Under normal sunlight- a balance of light from all parts of the spectrum from red to purple-the ratio of males and females born in most species is roughly 50-50. The scientific achievements as mentioned above are according to the laws initiated by the Creator of the universe, as referred to in the above verse. (See the word يشاء in Glossary).

I am inclined to think that the phenomenon described in the above verses is not related to the distribution of male and female offspring amongst the human beings. It rather relates to the occurence of sex amongst living organisms. Thus it means:

> "Allah is the Sovereign power in the Heavens and the Earth. His creation is controlled by His laws. The occurrence of female sex, or male sex; or both male and female sexes; or being without sex, is according to His law. He is replete with knowledge and is full of power to control the destinies according to His measures and set standards."

We know that amongst organisms there are some categories in which male and female sexes belong to different individuals; there are others who are hermaphrodites, i.e. have both male and female sexes in a single organism; still there are others who reproduce without sex. (The word عقيما may also be translated as unreproductive. In that case it would mean that it is also according to His law that some remain unproductive. The unproductiveness may be in individual cases or in groups, eg., in worker honeybee).

CHAPTER XIV

Self-Perpetuation: Adaptation

EVOLUTION

(10:4) إِنَّهُ يَبْدَؤُا الْخَلْقَ ثُمَّ يُعِيدُهُ ...

"He it is Who issues forth a thing in creation, and then gives it turns, time after time (to bring it gradually to its final shape)."

THEORY OF EVOLUTION.

History. Different theories about the origin of existing species including man came into vogue during the last few centuries. As they could not be supported by scientific evidence, they ultimately became obsolete one after the other. The actual forces that brought about evolution were gradually discovered and are now thoroughly understood.

The revealed books of Allah pointed towards organic creation thousands of years ago but human intellect was not mature enough to interpret their message. The verses of the Holy Quran relevant to the theory of evolution shall be described at the end of this chapter. But it may be pointed out here that the theory of special creation was in vogue since the time of Old Testament and it was based on the false interpretation of the saying, "God made the world in six days, man came last." The theory of special creation maintains that each kind of animal or plant came into existence in the form in which it exists today and it was specially designed to suit the conditions under which it was placed. Thus according to this theory no change has occurred since life began and consequently each species is fixed and immutable, propagating its own kind from generation to generation by reproduction and never changing into a different kind.

Primitive human races had various myths to explain the origin of man and animals by the creative acts of supernatural powers. Until the last century most of the people including such scientists as Linnaeus, Cuvier, Agassiz and Owen believed that species had been created separately. Cuvier thought that the disappearance of fossil species had resulted from a series of catastrophes, the last being the Noah's flood;and after each of these the earth had been repopulated by new creation of higher type. The belief in catastrophes was dispelled by the Scottish geologist Charles Lyell (1797-1875) who showed that the geological processes of sedimentation, uplift and erosion are essentially continuous. Some early Greek philosophers had vague notions of an evolutionary process. Anaximander, Empedocles, and Aristotle (6th to 4th century B.C.) independently came to the conclusion that living creatures possibly did not come into existence at random and independent of one another; they rather appeared in succession.

In the Middle Ages when the whole of Europe was averse to scientific pursuit, the Arabian Muslim scholars, Ibn Tufail, Ibn Badja, Abu-Nasar-Farabi, Ibn Miskawah, etc., in North Africa and Spain preserved the old branches of learning and also made some useful observations to strengthen the idea of evolution. Muslim thinkers were the pioneers in chemistry. When they found that the basic elements in the formation of inorganic and organic substances (both vegetable and animal) are the same, they became convinced of the idea of evolution. Dr. Stokel writes in his famous book "History of Philosophy" as follows-"The most important Arabian Philosophers in the West are Avenpace (Ibn Badja), Abu-Bucer (Ibn Tufail) and Averroes (Ibn Rushd). Avenpace and Abu Bucer dwell in their works on the idea of independent and gradual development of man." Un-fortunately we possess only a fragmentary knowledge of their contributions to this branch of science.

Francisco Redi, an Italian Physician (17th century), was the first to demonstrate experimentally the absurdity of the idea of special creation and proved that organisms could not arise from non-living sources. Contrary to former beliefs he demonstrated that maggots would never form spontaneously in meat, if flies were prevented from laying eggs on it.

Buffen, a French biologist (1707-1788), believed that animals were plastic, that small variations produced by the environments were accumulated to make large differences and that each animal in the ascending series of types was transferred from some simpler ancestor.

Jean Babtist de Lamarck (1744-1829), a French anatomist, proposed the first general theory which was outlined in 1801. Lamarck recognised a fundamental continuity in the dirverse kinds of animals and believed that there had been progressive development in form and structure. His theory briefed from his own words is as follows-"The environments affect the shape and organisation of animals: frequent or continuous use develops and enlarges any organ, while by permanent disuse it atrophies, until finally it disappears. All gains or losses acquired through the influence of environment and hence through *Use* and *Disuse* are preserved by reproduction, i.e., they are inheritable and could be transmitted to offspring."

Example I. Birds, he assumed correctly, were originally terrestrial. A land animal going to seek food in water would spread its toes to strike the water while moving about. The skin at the bases of toes would be continuously stretched and muscular movements of the legs would produce an extra flow of blood to the feet. In consequence, the skin would become enlarged in between the toes, as seen in ducks and other water-birds.

Example II. Disuse Lamarck illustrated by the structure of a snake. In crawling through grass its body would be stretched repeatedly to pass through narrow spaces and legs would not be used. Long legs would interfere with crawling and four short legs would not move the body. Legs are characteristics of reptiles and yet the snakes lost theirs. The eyes became lateral or dorsal, the better to see when on the ground, and the tongue developed as a protrusible sensory organ to detect objects in front of the snake.

Example III. Suppose a given short-necked ancestral animal feeds on tree leaves. As it clears off the lower levels of a tree, it stretches its neck to reach the upper branches. During a life-time of streching, the neck becomes a little longer and a slightly longer-neck is then inherited by the offspring. These in turn feed on tree leaves and keep on stretching their necks. This happens for many generations. Each generation acquires the gains of previous generations and itself adds a little to the neck length. In time a very long-necked animal is formed like a modern camel or a giraffe.

The theory was very popular in the beginning but has little support today. Because, though it is true that use and disuse lead to acquired variations, it is wrong to assume that such acquired variations are inheritable. The muscles of an athlete increase in strength and bulk with extensive exercise and recede if exercise is discontinued; but his children do not inherit such acquired characteristics of their father. The docking of tails in horses, sheep and bulldogs for many generations has not made their mutilations hereditary. These acquired variations are the effects produced by environment and development, and not by genes. The new organisms are developed from the germ cells of their parents and not from the somatic cells. The germ cells are set aside early in the growth of an individual and are subject to little or no effect from the body cells. This was demonstrated by Castle and Phillips who replaced the ovaries of a white guinea-pig with those from a black female. The former was then bred twice to a black male. All the six young produced were black and homozygous.

Darwin and the Theory of Natural Selection

Charles Darwin (1809-1882) was a methodical painstaking English naturalist of broad vision (Fig.69). As a young man (1831-1835), he served as naturalist on the "Beagle," a vessel that explored South America, the Galapagos islands and other regions. He undertook a five long years' voyage and collected a large number of different plants and animals. From his detailed notes and studies, he elaborated a new theory in his famous book, "On the origin of species by means of natural

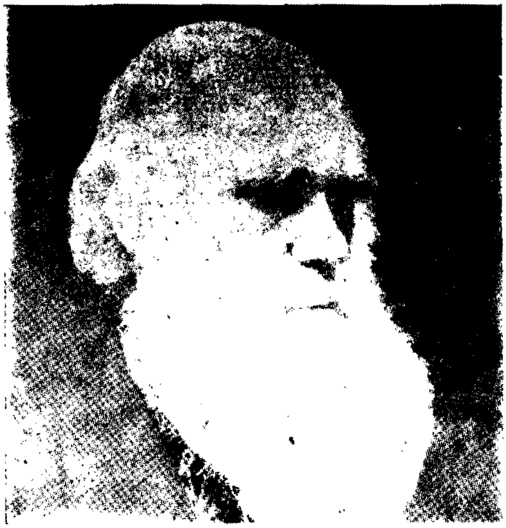


Fig. 69. -- CHARLES DARWIN.

Fig. 70. -- ALFRED RUSSEL WALLACE

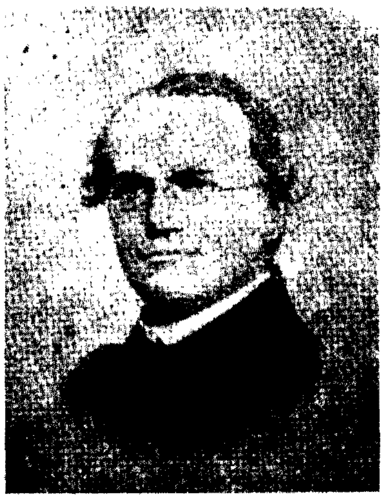


Fig. 71. -- GREGOR JOHANN MENDEL.

selection, or the preservation of favoured races in the struggle for life." It was published in 1859. Meanwhile another English naturalist, Wallace (Fig. 70) while studying the rich fauna and flora of the Malay Archipelago, independently arrived at similar conclusions. In 1858 he sent an essay on the subject to his friend Darwin. The essence of Darwin-Wallace theory is as follows:-

1. Variations of all degrees are present among the individuals and species in nature.

2. By the geometric ratio of increase, the numbers of every species tend to become enormously large; yet the population of each remains approximately constant because many individuals are eliminated by enemies, disease, competition, climate etc.

3. This involves a struggle for existence; individuals having variations unsuited to the particular conditions in nature are eliminated, whereas those whose variations are favourable will continue to exist and reproduce.

4. A process of Natural Selection is therefore operative which results in "the preservation of the favoured races."

Darwin and Wallace thus identified the environments as the principal cause of natural selection.

This is not the modern theory of evolution. In Darwin's day, laws of inheritance were unknown and he often could not distinguish the heritable variations, which alone are important in evolution, from non-inheritable variations produced by environments. Darwin recognised the widespread occurrence of variations but could not explain their origin.

It is true that under ordinary conditions animals never multiply enormously as indicated in Darwin's theory. The population in most species tends to remain more or less stationary because of various checks. These are limitations in food supply, shelter and breeding places. Individuals of a species compete with one another for these necessities and also with other species having similar requirements. An enlarged population may become a fertile field for parasites and diseases. A struggle for existence does exist, though it is not always a spectacular battle amongst animals but it is a continuous process in nature involving many factors, each of which eliminates certain individuals. It acts at any stage of life cycle of a species. All eggs will not get fertilised; after fertilisation all zygotes will not become adults and all adults will not survive and reproduce; after reproduction and multiplication all individuals will not be able to withstand the hazards of environments.

But this weeding out of individuals is not the principal cause of natural selection. There are two genuine objections to this consideration. First objection is that what is the cause of individual variations that occur amongst animals? Darwin had no answer to this question. For this he fell back to the Lamarckian idea of inheritance of acquired characteristics. The other objection to Darwin's theory is about the natural selection itself. The question is, if it is only a process of weeding out of what already exists, how can natural selection create anything new? Actually it does create novelty.

Besides the above two genuine objections, criticism on Darwin's theory arose in his own time and continues up till now. This criticism was based on wrong interpretation of the theory, not by biologists but by non-scientists. They thought that the essence of natural selection was 'struggle for existence'. Alternative slogans like 'survival of the fittest' and 'might is right' came into vogue. The natural selection thus came to be considered as a negative and destructive force. This had some unfortunate consequences. Firstly, the positive contribution of Darwin in explaining the process of evolution, i.e., the creative role of 'natural selection' became overshadowed by this propaganda. Secondly, in popular thinking the negative aspect of Darwin's concept came to be considered as a final word concerning evolution. As a result the idea of evolution itself came to be ridiculed and rejected. Even today our orthodox Muslims are allergic to the word evolution. As the idea of evolution goes against the idea of 'special creation' of man, it is considered by them as anti-religious, although it does not affect belief in Allah. To a believer in Allah, it is the way of Allah that operates and Allah as such is not in question. Moreover, the verses that support the idea of evolution lie scattered all over the pages of the Holy Quran.

We now realise that Darwin's theory was the first to point in the right direction, though the explanation supplied by Darwin and Wallace was incomplete. Darwin made the greatest contribution to the explanation of evolutionary process. Theory of natural selection still forms a part of modern theory of evolution but it has been realised now that natural selection is pre-eminently a peaceful process and has very little to do with 'struggle' or 'might is right'.

Mendel (Fig. 71) paved the way for the completion of what was left incomplete by Darwin and Wallace. Mendel's laws of inheritance (described in the last chapter) published in 1866, were not generally known until 1900. In fact the modern theory of evolution is not the work of any one man. Rather it evolved slowly during the first half of the current century. Starting about 1875, biologists began to study the processes in germ cells and their relation to reproduction. A little later attention was given to experimental breeding. Soon there was a wealth of new knowledge that afforded a clear understanding of the manner of origin of heritable variations and the ways they are passed from generation to generation. In recent years experimental breeding has been accompanied by a study of the related changes in germ cells. These fields are combined as cytogenetics. The details of chromosome behaviour and of genetic processes, important for understanding certain evolutionary processes, have already been discussed in the previous chapter. We may here summarise the essential points as follows:-

1. Chromosomes in cell nuclei carry genes for development of traits in individuals.

2. Meiosis segregates members of homologous chromosome pairs and halves the total number of chromosomes for each gamete.

3. Fertilisation, the random union of two gametes of unlike sex, brings together assortments of chromosomes (and therefore of genes) from two parents, resulting in production of individuals with different gene combinations.

4. Mutations occur in genes. Mutations and chromosome changes, as described above, together result in altering the assortment of genes (and hence traits) which are passed on to succeeding generations.

Gene Changes and *Natural Selection*. Mutation and chromosome recombinations through sex, result in populations with altered assemblages of old and new characters thus increasing the total variability. On the other hand, natural selection works in the direction of narrowing species variability by eliminating characters that are non-adaptive or of no value for survival. The total effect that the physical and biological environments impose on individuals is the 'Screen' of natural selection. It passes or permits those better suited to survive and eliminates all others.

The Process of Evolution. As noted above, the basis of the evolutionary process are the inheritable variations which appear among the individuals of a population; and the mechanism of evolution may thus be described as natural selection acting on the inheritable variations of that population. A population may be defined as a group of individuals belonging to a species, that are located within a geographical boundary. They interbreed with the members of their own group and occasionally with members of other populations (Fig. 72). Within a certain population, the sexual communication shall result in a free flow of genes between individuals and in due course of time, through successive generations, the genes shall get thoroughly mixed up. In each generation some individuals may develop new traits through sex and mutation. If these individuals survive and reproduce, these new traits may spread within that particular population, depending on natural selection. It is evident that those who produce more offspring, their genes will become more numerous in the gene pool of that population, as compared with those who produce a lesser number. Therefore if a new trait appears in a certain individual and his offspring become numerically more and more abundant, then that new trait will spread rapidly throughout that population

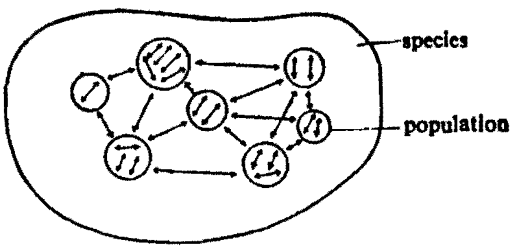
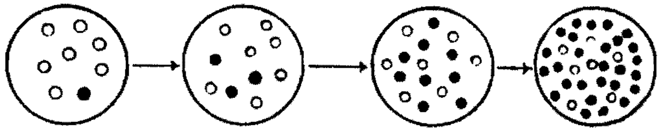


Fig. 72.—In a species gene flow occurs within and between populations.

(Fig. 73). As a result, a trait variation originating in one organism will become a permanent feature of that population as a whole. This is the unit of evolutionary change. Many such unit changes must accumulate in a population before the organisms are sufficiently altered in structure and function to be established as a new species.



parent generation	first offspring generation	second offspring generation	third offspring generation
1 in 8	3 in 10	9 in 16	27 in 34
12½%	30%	56%	79%

Fig. 73.--EFFECTS OF DIFFERENIAL REPRODUCTION.

Suppose a variation occurs in one individual of a parent generation and the variant organism is able to leave three offspring, and if the non-variant individuals on the other hand happen to leave one offspring each, and if this happens through successive generations, the ocmplexion of population shall change as shown above.

It is evident from the above that natural selection is a peaceful and creative force which spreads genetic novelty. It is not 'struggle for existence' or 'survival of the fittest'. Physical struggles are present but they have an indirect and very limited effect on the evolutionary process. A fit individual may be strong enough to kill and eliminate a weaker one but the point is, which one of the two has contributed more to the gene pool of the population during his life-time! A fit and dominant individual may be sterile and hence his contribution to gene pool is nil. It is not his choice to eliminate others that counts but his contribution to the gene pool of a population.

It may be pointed here that the Holy Quran calls all that happens in nature independent of the choice of the creatures as "the ways of Allah". Thus, according to the Quranic conception, the term "natural selection" would mean that the selection in the process of evolution takes place according to the laws laid down by Allah and not according to individual choice. One is simply amazed to see how beautifully the Quran explained this fundamental truth fourteen hundred years ago when nobody could even dream of the phenomenon of natural selection. Says the Quran:

وَرَبُّكَ يَخْلُقُ مَا يَشَاءُ وَيَخْتَارُ مَا كَانَ لَهُمُ
الْخِيَرَةُ سُبْحَانَ اللَّهِ وَتَعَالَىٰ عَمَّا يُشْرِكُونَ (28:68)

"The creation and selection occur according to the law of thy Sustainer. They (the creatures) have got no choice in it. Glory be to Allah. He is far above the partners they ascribe to Him."

Formation of Species. Species formation acutally, is the level at which evolution appears in its manifest form. As already noted, species is a group of individuals which closely resemble each other, mate freely with one another, and produce fertile offspring. It may also be defined as a group of individuals sharing the

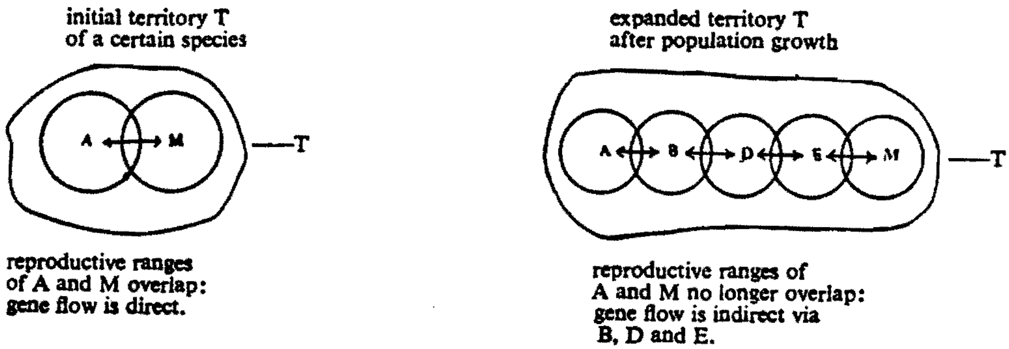


Fig. 74--ISOLATION OF POPULATIONS, RESULTS IN REPRODUCTIVE ISOLATION.

same gene pool. Above we have dealt with the process of species formation. The main question is how does the genetic barrier between two different species arises? The process of species formation is closely related to Isolation. Primarily it is the geographical isolation i.e., physical separation in distance. The individuals of any species are not uniformly distributed, but small groups more or less isolated from one another, are unevenly distributed along the entire geographical range. The groups do not intermingle except at their boundaries, because of limited power of locomotion or various barriers. Let us take for example a territory T which is inhabited by two populations A and M belonging to the same species (Fig. 74). These two populations have overlapping boundaries. The flow of genes shall take place freely, through sexual communication between the individuals of two populations, at the border areas overlapping each other. As the populations grow through successive generations, they shall occupy a wider area and territory T shall get expanded. After a lapse of time, populations A and M at the farther ends of territory T would become so farther apart that direct interbreeding between these two populations would not be possible. Gene flow, however, would still be possible through the interconnecting populations, B, D, and E. Inheritable variations are bound to arise in populations A and M, and in due course of time they will form sub-species by Differential Reproduction (Fig. 75).

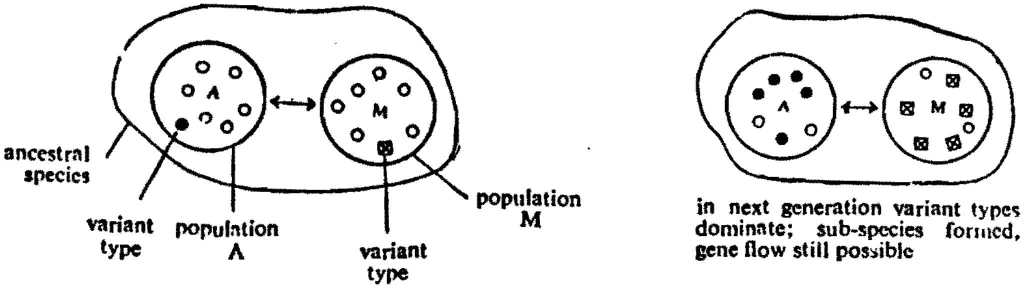


Fig.75.-FORMATION OF SUB-SPECIES.

Inheritable variations shall continue to accumulate through further generations until they become so great that no more gene flow shall be possible between the subspecies A and M. The geographical isolation shall give rise to:-

(*a*) *Ecological Isolation*, i.e., the two segregated stocks A and M may happen to live in different environments.

(*b*) *Seasonal Isolation*, i.e., the breeding time of A and M may become different.

(*c*) *Physiological Isolation*, i.e., the reproductive organs may so change that sexual communication between the individuals of A and M stocks becomes mechanically impossible. The protein specifications of two stocks may so change, that gametes of A and M become incompatible with each other; so that one cannot fertilise the other.

(*d*) *Behavioural Isolation*, i.e., the individuals of stocks A may not accept psychologically a mate from stock M.

The geographical isolation thus becomes biological isolation and populations A and M become two different species (Fig.76). The evolution of a new species, on the average, takes one million years.

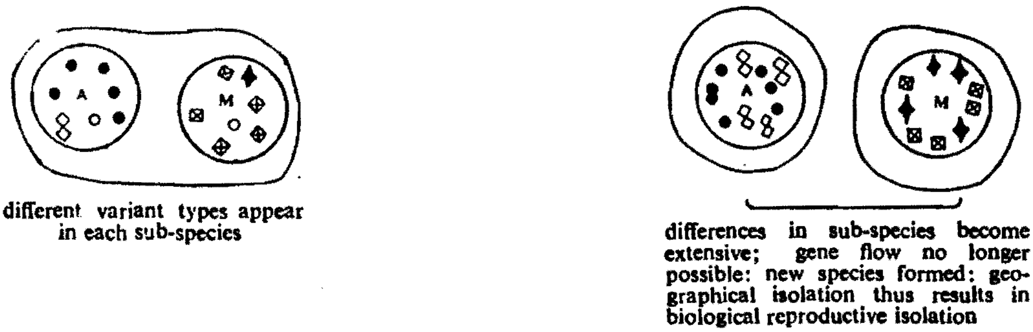


Fig. 76.-ORIGIN OF DIFFERENT SPECIES, THROUGH SUB-SPECIES, FROM A COMMON ANCESTOR.

CHARACTERISTICS OF EVOLUTION

Time Factor. As noted above, evolution is a very slow process even at the species level and at orders, classes, or phyla level it is far too slow. The genetic novelties gather bit by bit through generations. The individuals or the groups carrying novelties have got to pass through the screen of natural selection. If they are not fit to adapt themselves to the new environments, they will die. Even if a useful genetic novelty does occur, it is not necessary that similar novelties shall be added to it in the next generations. Thus even though evolution may occur, the process would be extremely slow. As already noted in the chapter on marine life, the more stable the environments, the more slow would be the evolutionary process.

Tree-like Pattern. The old idea that evolution took place from amoeba to man in a ladder-like fashion, i.e., every higher animal evolved directly from a lower one, is now obsolete. As soon as a new type evolves, it becomes a potential ancestor for many simultaneous descendant lines and each line becomes specially adapted in a particular way. The evolution thus forms the pattern of a branching tree (Fig.77 and frontispiece). The Holy Quran said 1400 years ago:

(71:17) وَاللّٰهُ اَنْۢبَتَكُمْ مِّنَ الْاَرْضِ نَبَاتًا ۙ

"Allah has raised you up from the earth in the form of a (genealogical) tree".

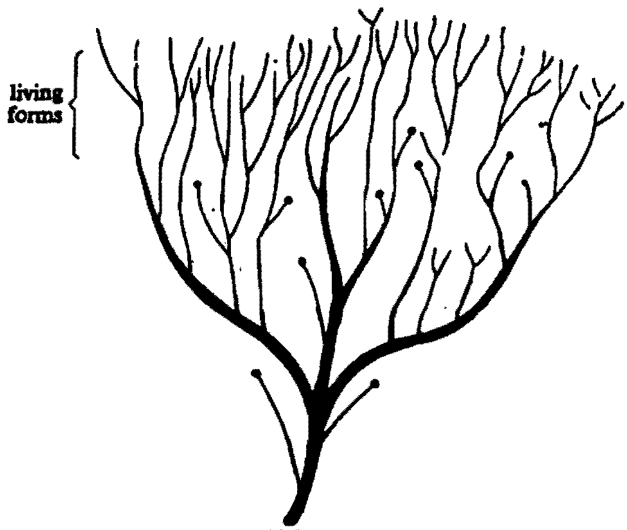


Fig. 77.--BUSH PATTERN OF EVOLUTION.

The uppermost branches show living forms. Round-ended branches represent extinct forms.

Extinction. The above figure shows that all the branches of genealogical tree did not go right up to the top. Some of them terminated midway and became extinct. This is because some groups were not able to adapt themselves to changed environments. They could not pass through the screen of Natural Selection. Suppose, a herbivore (vegetable eater such as sheep or rabbit) and an omnivore (one who lives both on vegetable and animal food, like man) both live in the same locality. If such circumstances arise that both have to live on vegetable, the herbivore shall have a competitive advantage. He shall be able to find food easily and utilise it better. On the other hand, if vegetable disappears from the locality, the herbivore shall not survive, while the omnivore shall be able to utilise other foods. Thus specialisation and adaptive flexibility both have certain advantages, as well as disadvantages, and survival and extinction depend upon a fine balance between the two.

Replacement. Some of the extinct groups may be replaced by functionally similar groups. The replacement might occur millions of years after extinction of the first group. For example Pterosaurs, the flying reptiles of Mesozoic Era, became extinct and bats occupied the same position after the mammals were evolved.

Convergence and Divergence. We noted already that different lines radiate from a common ancestor, all adapted to different environments in different ways. Such development of varied characteristics in closely related groups is called *Evolutionary Divergence*.

On the other hand, two groups not related to each other, adapt same type of environments. For example, Pterosaur and bat, one a reptile and the other a mammal, both adapted to flying. Similar is the case with Ichthyosaurs and Dolphins; or with birds and insects. Thus the phenomenon of replacement is often accompanied by that of convergence. Convergence leads to functional similarity but not structural identity, as we see in the case of wings of insects and birds.

The above outlines the general characteristics of evolutionary process. It has been extremely slow, with the phenomena of extinction and replacement, divergence and convergence occurring here and there, and at varying intervals. The overall result of evolution has been an increase in the living matter, both as regards the number and types of organisms. New environments have been created in the process with new possibilities of life. As for example, the emergence of trees lead to the emergence of arboreal life and in turn to the emergence of man. Man in turn created new environments which are being exploited by new plants and animals, as we see in the case of agriculture or in the cross breeding of domestic animals. Thus evolution is not a closed book, an event that has been completed in the past, but rather a process which is actually going on at present. It is rather an accelerating process that is gaining momentum.

The progressive creative expansiveness is described by the Holy Quran as follows:

اَلْحَمْدُ لِلّٰهِ فَاطِرِ السَّمٰوٰتِ وَالْاَرْضِ جَاعِلِ الْمَلٰٓئِكَةِ رُسُلًا
اُولِيْٓ اَجْنِحَةٍ مَّثْنٰى وَثُلٰثَ وَرُبٰعَ يَزِيْدُ فِي الْخَلْقِ مَا يَشَآءُ
(35:1) اِنَّ اللّٰهَ عَلٰى كُلِّ شَيْءٍ قَدِيْرٌ

> "Praise be to Allah Who created (out of nothing) the heavens and the earth: Who made the forces of nature, the means to execute His planning. Some of these forces have got two, three or four (*i.e.*, multiple) roles to perform. *He adds to creation according to His laws*. He made specific standards for the process of creation and has perfect control over them."

As regards a certain natural force performing multiple functions, as pointed out in the above verse, we have noted so many phenomena that have been described in the previous chapter. For example, the heat rays of the solar spectrum, provide activating energy for the chemical processes on the earth. At the same time, all the cyclic changes in the hydrosphere are produced by them : through their effect on Hydrosphere, they influence climates, humidity, winds, waves and currents etc. We are also familiar with the light rays of the solar spectrum. We need light for vision. On the other hand the process of photosynthesis in green plants, all over the world, depends on the light rays. In addition, the heat and light rays perform many other functions and so is the case with the other forces of nature-"The angels with several wings."

The Orthodox Muslims Support the Theory of Special Creation. As pointed out earlier, the theory of special creation was in vogue since the time of the Old Testament. The ancients having an extremely rudimentary knowledge of the phenomena of nature were not able to realise distinctly the meaning of the revealed verses. The commentators of the Holy Quran also interpreted the Quranic verses on similar lines, and being influenced as already stated, by the Jewish literature, they have produced fantastic stories of Adam and Eve and the propagation of human species as such from the very beginning. It is a contradiction of the Quranic verses. It is abundantly clear that the story of Adam, Malaika and Satan, as it appears in the Holy Quran, is allegorical. The word 'Adam' here represents the human species, 'Malaika' the forces of nature and 'Satan' the human sentiments (the emotional weakness of man).

The Quran Strongly Supports the Theory of Organic Evolution. If we take the version of the orthodox Muslims that Adam was a particular person, the first human being created direct from the earth, as correct, then what about those verses of the Quran which repeatedly describe the evolution of man from one stage to another? For example, when the Holy Quran says:

هُوَ الَّذِي خَلَقَكُم مِّن تُرَابٍ ثُمَّ مِن نُّطْفَةٍ ثُمَّ مِنْ عَلَقَةٍ ثُمَّ يُخْرِجُكُمْ طِفْلًا
ثُمَّ لِتَبْلُغُوا أَشُدَّكُمْ ثُمَّ لِتَكُونُوا شُيُوخًا وَمِنكُم مَّن يُتَوَفَّىٰ مِن قَبْلُ وَ
(40:67) لِتَبْلُغُوا أَجَلًا مُّسَمًّى وَلَعَلَّكُمْ تَعْقِلُونَ ٥

"It is He Who created you from dust, then from a little fluid (stage of the appearance of reproductive units), then from 'Alaq' (stage of intra uterine development). Then He brings you forth as a child, then lets you reach the age of your full strength, then He lets you become old, then some of you die earlier, others reach a term appointed for them (each species having a different span of life). (This is being explained to you) so that you get wisdom."

The word 'Summa' in this verse clearly indicates the stages step by step. Firstly, the stage of initiation of life in the inorganic matter. Secondly, the stage where reproductive units appeared. Thirdly, the stage where uterus developed in the organisms and the development of fetus inside the uterus got initiated. Again after birth man passes through the stages of childhood, adulthood and old age before he dies.

Our commentators omit all the intermediary stages and on account of their lack of knowledge of natural phenomena, try to build an imaginary adult man directly out of clay.

At yet another place the Holy Quran says:

هَلْ أَتَىٰ عَلَى الْإِنسَانِ حِينٌ مِّنَ الدَّهْرِ لَمْ يَكُن شَيْئًا مَّذْكُورًا ٥ (76:1)

> "Had there not been upon Man a period of time when he was not a thing worth mentioning?"

The verse clearly points towards that period of human evolution which existed before he actually assumed the form of a human being. Because at the stage of becoming a man he wielded a position of such magnificent importance that according to the Holy Quran, 'Malaika', the forces of nature bowed down before him. How can a creation which is not even worth mentioning, command such a position?

Circumstantial Evidence in Support of the Theory of Organic Evolution. There are certain phenomena which provide direct evidence in support of the theory of organic evolution.

Vestigeal Organs. Many animals possess certain organs which perform no useful function and are in a more or less degenerated condition. These are called vestigeal organs. We cannot possibly explain the existence of these organs on the basis of the theory of special creation, which maintains that each species and its organs are specially created to meet the requirements of a particular environment. According to this theory, therefore, no animal can have useless organs. The presence of such organs on the other hand can be readily explained on the assumption that they are the remnants of the organs which were fully developed and functional in the animal's ancestors and have now undergone changes through the normal processes of evolution. Hundreds of these vestigeal organs can be enumerated in the animal kingdom. The presence of appendix and the muscles controlling the movements of external ear can be quoted as examples in man.

Embryological Evidence. The embryos of animals belonging to a class or even to a phylum represent a remarkable resemblance to one another. The nearer the animals are in their adult form the closer and longer is their similarity in their development stages. The more they differ in their adult form the sooner their embryos diverge in structure and general appearance during development. This is evident from Fig.63.

Palaeontology. Many creatures that did not survive prehistoric times, succumbed to environmental changes. Geological upheavals caused lakes and swamps to disappear robbing many reptiles of suitable habitats. Climatic changes accounted for the extinction of many species that were unable to withstand extreme conditions

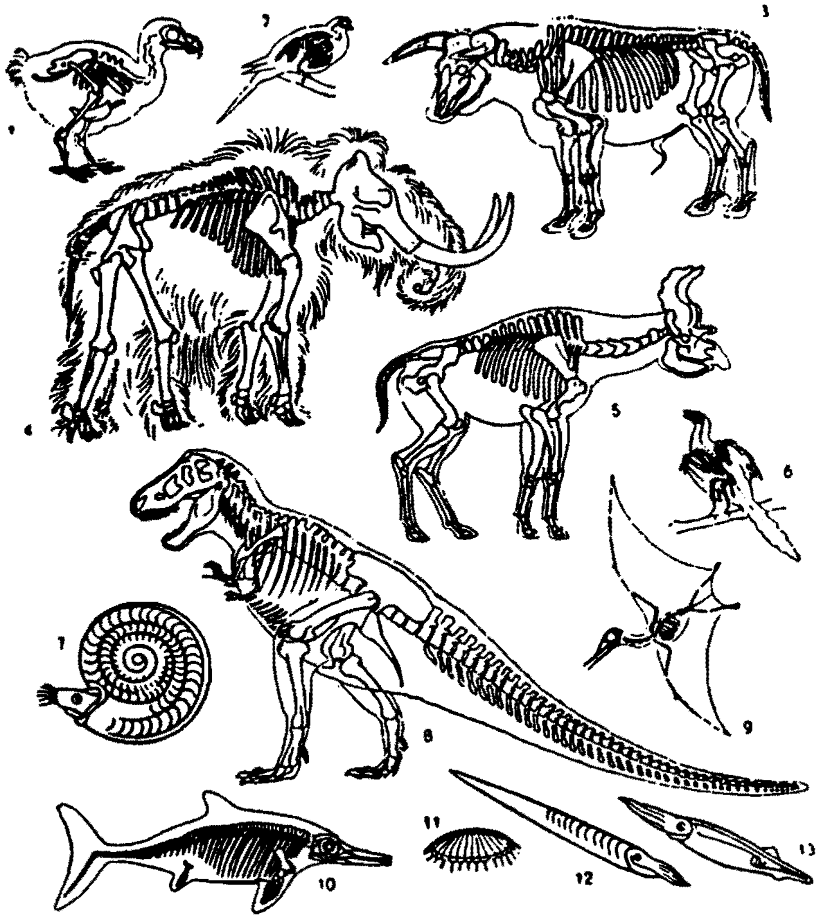


Fig. 78.--SOME FOSSILIZED EXTINCT ANIMALS.

1.--Dodo, extinct since end of the 17th c.
2.--Passenger pigeon, extinct about 1900.
3.--European wild ox, extinct since late Middle Ages
4.--Elephant adapted to glacial periods--Cainozoic Era.
5.--Hoofed herbivorous mammal--Cainozioc Era.
6.--Archaeopteryx, reptilian ancestor of birds--Mesozoic Era.
7.--Mollusc--Mesozoic Era.
8.--Tyrannosaurus, largest carnivore that ever lived on land, 47 feet long, 20 feet high--Mesozoic Era.
9.--Pterosaur--Mesozoic Era.
10.--Ichthyosaur--Mesozoic Era.
11.--Jelly-fish, 20 feet in diameter--Palaeozoic Era.
12.--Mollusc, 12 feet long--Palaeozoic Era
13.--Cephalopod mollusc, 18 inch long--Mesozoic Era.

particularly cold. Such changes of conditions also affected plant life. Thus herbivorous animals died and the carnivores that lived on them could not survive. The fossilised relics of these extinct species are today contained in the rocks and a study of these fossils (Fig.78) furnishes a direct evidence in favour of the doctrine of organic evolution. Among fossils are found relices of many forms which, though extinct now, throw light on the relationship of existing groups of animals and serve to connect groups which at present appear to be quite distinct from one another. For example, a look at the genealogical tree in the fronuspiece shows that the birds originated from the reptiles. Apparently these two groups of animals appear to have no connecting link between them but such a link does exist among the fossils.

(*a*) (*b*)

Fig. 79.—ARCHAEOPTERYX.
(reptilian ancestor of birds)
(*a*) fossil. (*b*) reconstructed.

Fig.79--ARCHAEOPTERYX.

Archaeopteryx (Fig. 78-6) & (Fig. 79) is the reptilian ancestor of the birds. This survival and extinction of species takes place according to set laws of nature, as stated by the Quran:

(13:39) يَمْحُوا اللّٰهُ مَا يَشَآءُ وَ يُثْبِتُ وَعِنْدَهٗٓ اُمُّ الْكِتٰبِ ۝

> "Allah causes (some species) to extinguish and others to survive and get established, according to law, the source of which is with Him."

Geographical Distribution of Animals. This strongly supports the theory of organic evolution. From the time terrestrial animal-life began, millions of years ago, the face of the Earth has undergone immense changes, and even in the relatively recent period since mammals evolved from the reptiles, more reshaping of land has occurred. It was once possible for species from Southern Asia to spread by age-long migration through Europe, by means of a land-bridge at the present site of the Bering Strait, to Americas. But barriers to migration, and new avenues to them, have been appearing and disappearing since the time creatures first had need to travel in search of food and warmth. The formation of desert created one of the barriers to migration, so that the mammals to the south of the desert, living in tropical and semi-tropical conditions, have evolved in quite a different way from the mammals to the north of it. In Australia, the most primitive species of mammals in the world have survived, for with the disappearance of any land connection with Asia some 135 million years ago, they became isolated, and more active and dominating mammals were prevented from reaching the area. The Himalayas, formed about 25 million years ago, stopped any large-scale interchange of species between northern Asia and oriental region; and the Bering Strait, during the recent Pleistocene period, effectively cut off Americas from Europe and Asia.

Geological movements left mammals marooned in the cold north and these became hairy, like the polar bear and the musk-ox. On the other hand, in the tropics the elephant and the hippopotamus became almost hairless. Thus on account of the barriers to migration and the difference in environments the animals in different parts of the globe have passed through different evolutionary history. The mammals can now be grouped in five main regions, each of which is bounded by natural barriers-mountains, deserts and seas.

ORGANIC EVOLUTION AND THE QURAN

The Holy Quran supports the theory of organic evolution, or rather the theory of organic evolution supports the Quran. This is because the Quran pointed towards evolution in the 7th century A.D., while the theory of organic evolution was propounded in the 19th century.

The Quran points out that the creation of the universe is progressive and according to plan. From the point of start to the point of destination, every scheme unfolds itself, through various evolutionary stages, step by step; each stage being completed in many thousand years:

يُدَبِّرُ الْأَمْرَ مِنَ السَّمَاءِ إِلَى الْأَرْضِ ثُمَّ يَعْرُجُ إِلَيْهِ
فِي يَوْمٍ كَانَ مِقْدَارُهُ أَلْفَ سَنَةٍ مِمَّا تَعُدُّونَ ۝

(32:5)

> "He plans affairs from His highest seat of Authority. When a plan is intended to be executed, its starting point is made at the lowest level. Then it is raised up step by step to its highest level (passing through various evolutionary stages). It arises from one stage to another in a certain period which may be a thousand years of your reckoning." At still another place it is said, fifty thousand years (70:4).

Allah's plans become manifest when we earnestly explore the working of the Divine laws in the universe and when we contemplate the creation of the terrestrial animals moving about on the land:

إِنَّ فِي السَّمَاوَاتِ وَالْأَرْضِ لَآيَاتٍ لِلْمُؤْمِنِينَ ۝ وَفِي خَلْقِكُمْ وَمَا يَبُثُّ
مِنْ دَابَّةٍ آيَاتٌ لِقَوْمٍ يُوقِنُونَ ۝ (45:3-4)

> "Verily in the heavens and the earth are significant signs for those who believe in the working of the Divine law; and in the creation of your ownselves and that of the moving creatures that are scattered (on the earth) are signs for those with assured knowledge."

The scientific research in the field of Biology which discloses the structural resemblances between man and other animals, unfolds every page of the history of animal evolution, step by step:

وَمَا مِنْ دَابَّةٍ فِي الْأَرْضِ وَلَا طَائِرٍ يَطِيرُ بِجَنَاحَيْهِ إِلَّا أُمَمٌ أَمْثَالُكُمْ
مَا فَرَّطْنَا فِي الْكِتَابِ مِنْ شَيْءٍ ثُمَّ إِلَىٰ رَبِّهِمْ يُحْشَرُونَ ۝ (6:38)

> "There is not an animal that moves on the earth, nor one that flies on its wings but forms a species with a (structural) resemblance to yourselves. We have not neglected anything in the Book of Nature (i.e., We have given them a complete code of life). They are bound to obey His guidance."

The more we explore nature, the more accurately we get a clear record of the past evolution, including the nutritional evolution on the earth. In the depths of the earth we find stories[1] of the past, written on stones explicitly and in details. The Holy Quran says that creatures in their evolutionary history have passed through different stages; each type of creature remained temporarily in one particular stage and was then handed over to the next stage for further disposal; and that Allah knows their nutritional needs at every stage, which are met with according to his laws: .

وَمَا مِنْ دَابَّةٍ فِي الْأَرْضِ إِلَّا عَلَى اللَّهِ رِزْقُهَا وَيَعْلَمُ
مُسْتَقَرَّهَا وَمُسْتَوْدَعَهَا كُلٌّ فِي كِتَابٍ مُبِينٍ ۝ (11:6) [2]

> "There is not a moving creature on the earth but its sustenance depends on Allah. He knows how long a creation shall stay temporarily in one stage and when it shall be handed over to the next stage (and what type of nutrition they need at each particular stage). All is in clear records."

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[1]The subject of "stories in stones" shall be dealt with in Chapter 15.
[2]For the words مستقر and مستودع see Glossary.

The word دابه or 'moving creatures' in the above verses is explained further by the Holy Quran:

وَاللّٰهُ خَلَقَ كُلَّ دَآبَّةٍ مِّنْ مَّآءٍ فَمِنْهُمْ مَّنْ يَّمْشِىْ عَلٰى بَطْنِهٖ وَمِنْهُمْ مَّنْ يَّمْشِىْ عَلٰى رِجْلَيْنِ وَمِنْهُمْ مَّنْ يَّمْشِىْ عَلٰى اَرْبَعٍ يَخْلُقُ اللّٰهُ مَا يَشَآءُ اِنَّ اللّٰهَ عَلٰى كُلِّ شَىْءٍ قَدِيْرٌ

(24:45)

"And Allah has created all motile creatures from water. Of these there are some who crawl on their bellies (e.g., a large variety of animals including worms and some of reptiles); some who move on two legs(e.g., man) and some that move on four (quadrupeds). For Allah creates according to His laws which have full control over all things." (See Frontispiece).

The following verses of the Holy Quran pertaining to evolution are significant:

(10:4) ... اِنَّهٗ يَبْدَؤُا الْخَلْقَ ثُمَّ يُعِيْدُهٗ ...

"He it is Who issues forth a thing in creation, and then gives it turns, time after time (to bring it gradually to its final shape)."

(85:12) اِنَّهٗ هُوَ يُبْدِئُ وَيُعِيْدُ

"He it is Who initiates creation and then recreates (in ascending order)".

Again, as regards the human evolution the Holy Quran says:

(84:19) لَتَرْكَبُنَّ طَبَقًا عَنْ طَبَقٍ

"Surely you are (and shall be) raised up from one stage to the other step by step."

The word اطوارا as used by the Holy Quran is remarkable. The entire evolutionary process has been condensed in one word:

(71:14) وَقَدْ خَلَقَكُمْ اَطْوَارًا

"He it is Who created you in different stages, forms, measures and environments."

Again man is reminded of his pre-human evolutionary stages as follows:

(19:67) اَوَلَا يَذْكُرُ الْاِنْسَانُ اَنَّا خَلَقْنٰهُ مِنْ قَبْلُ وَلَمْ يَكُ شَيْئًا

"Does not man call to mind that We created him before, when he was not a thing (worth mentioning)?"

The Holy Quran does not describe things in a text-book style. It rather points out the different aspects of a particular subject in different contexts, and the real import of the subject becomes manifest when all such pieces are joined together. In the verse that follows only two broad-based stages of human creation are mentioned: the creation of life in the inorganic matter and the present stage of sexual reproduction in man:

... هُوَ أَعْلَمُ بِكُمْ إِذْ أَنشَأَكُم مِّنَ الْأَرْضِ وَإِذْ
أَنتُمْ أَجِنَّةٌ فِي بُطُونِ أُمَّهَاتِكُمْ ... (53:32)

"(He knows your shortcomings as well as your potentialities). He knows you well (from the time) when you were initially raised up from the inorganic matter of the earth and (again) when (in the sexual stage of evolution) you lay hidden inside your mothers' wombs."

The under-mentioned verses have already been quoted in relation to reproduction amongst multicellular animals in Chapter XII:

وَلَقَدْ خَلَقْنَا الْإِنسَانَ مِن سُلَالَةٍ مِّن طِينٍ ۝ ثُمَّ جَعَلْنَاهُ نُطْفَةً فِي قَرَارٍ
مَّكِينٍ ۝ ثُمَّ خَلَقْنَا النُّطْفَةَ عَلَقَةً فَخَلَقْنَا الْعَلَقَةَ مُضْغَةً فَخَلَقْنَا
الْمُضْغَةَ عِظَامًا فَكَسَوْنَا الْعِظَامَ لَحْمًا ثُمَّ أَنشَأْنَاهُ خَلْقًا آخَرَ فَتَبَارَكَ اللَّهُ أَحْسَنُ الْخَالِقِينَ ۝ (23:12-14)

"We created man from the extracts of clay. Then We placed him as a reproductive unit in its temporary abode, to be firmly fixed. From the reproductive unit We created 'Alaqa' (hanging mass inside the blastocyst). Then We created (inside) the 'Alaqa' a 'Muzgha'. Then We created bones inside the 'Muzgha'. Then We covered the bony framework with muscles. Then We brought him forward as a new and distinguished creation. So blessed be Allah Whose creation is most proportionate."

Here three distinct stages of human creation are pointed out:

(1) The stage where life gradually appeared in the inorganic matter.
(2) The stage of sexual reproduction and a brief account of the stages of development of embryo in Vivipara.
(3) خَلْقًا آخَرَ Or the stage where man appeared on the scene as a new and distinguished creation. The distinguishing features of this new creation being the development of mind through the agency of hearing and sight; and the appearance of the faculties of 'freedom of choice' and 'will'. Thus the Holy Quran says:

الَّذِي أَحْسَنَ كُلَّ شَيْءٍ خَلَقَهُ وَبَدَأَ خَلْقَ الْإِنسَانِ مِن طِينٍ ۝ ثُمَّ جَعَلَ
نَسْلَهُ مِن سُلَالَةٍ مِّن مَّاءٍ مَّهِينٍ ۝ ثُمَّ سَوَّاهُ وَنَفَخَ فِيهِ مِن رُّوحِهِ وَ
جَعَلَ لَكُمُ السَّمْعَ وَالْأَبْصَارَ وَالْأَفْئِدَةَ قَلِيلًا مَّا تَشْكُرُونَ ۝ (32:7-9)

> "It is He who has made, every thing which He has created in an appropriate form and initiated the creation of man from the inorganic matter of the earth; and made his progeny from an extract of (what may seem to you) a despised fluid. Then He fashioned him in proper form and breathed into him His 'Ruh' and invested you with the faculties of hearing; seeing; and feeling and intellect(mind). But very few of you make the right use of these faculties."

Two preliminary stages are described above before man reached the stage of a distinguished creation-the stage of the creation of life in the inorganic matter of the earth and the stage of sexual reproduction. In these stages the prehuman creation is described in the form of a *third person*(نسله، سواه، فيه). But the stage at which the senses of sight and hearing and the mind are developed, and the faculty of Freedom of Choice and Will have come into existence, the Holy Quran addresses man in the form of a *second person*(لكم): which clearly indicates that man reached its present form gradually and progressively, step by step, every step being in the ascending order.

The above are a few out of a number of verses of the Holy Quran which point towards organic evolution.

The Holy Quran lays great stess on exploration and observation, as it affirms belief in the past evolution and consequently the belief in the evolutionary stages that lie ahead, in this world and the hereafter,. Above all, it affirms belief in the Creator Himself, Who is described by the Holy Quran as رفيع الدرجات[1] the One who elevates His creation step by step.

Thus it is said:

أَوَلَمْ يَرَوْا كَيْفَ يُبْدِئُ اللَّهُ الْخَلْقَ ثُمَّ يُعِيدُهُ ۚ إِنَّ ذَٰلِكَ عَلَى اللَّهِ يَسِيرٌ
قُلْ سِيرُوا فِي الْأَرْضِ فَانظُرُوا كَيْفَ بَدَأَ الْخَلْقَ ۚ ثُمَّ اللَّهُ يُنشِئُ النَّشْأَةَ
الْآخِرَةَ ۚ إِنَّ اللَّهَ عَلَىٰ كُلِّ شَيْءٍ قَدِيرٌ (29:19-20)

> "Do they not observe how Allah originates creation, then progressively recreates. Truly that is easy for Allah. Say: Go through the earth and see how Allah did originate creation: so will Allah give fresh life to created objects after a while, for Allah has measures to execute his plans."

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[1] 1. The word رفيع الدرجٰت (40:15) may also be interpreted as "Raised high above ranks or stages." In that case it would mean that Allah Hinmself is high above the world of change or the process of evolution. The Holy Quran describes Allah as هو الاول و الاخر (57:3), i.e., He was present before the process of creation of the universe began and He shall be present after the universe ends.

2. See Glossary for the words آخَرَ in 23:14 and آخِرَةَ in 29:20.

CHAPTER XV

Self-Perpetuation : Adaptation

THE PAST EVOLUTION

إِنَّ رَبَّكُمُ اللّٰهُ الَّذِي خَلَقَ السَّمٰوٰتِ وَالْأَرْضَ فِي سِتَّةِ أَيَّامٍ
ثُمَّ اسْتَوٰى عَلَى الْعَرْشِ يُدَبِّرُ الْأَمْرَ (10:3)

"Verily your Sustainer is Allah Who created the heavenly bodies and the earth in six eras, and He established His well balanced control over it, from His throne of Authority, planning His schemes."

TIME-SCALE OF EARTH'S EVOLUTION

There are several sources of evidence which reveal the time course of past evolution on the earth. As already noted, one of them is the presence of fossils of formerly living plants and animals. Fossils provide the direct evidence of the kinds of organisms that lived on the earth at various periods in the past. The other main evidence we get from the comparative study of structures of the living organisms. The modern plants and animals reflect in their architecture the Evolutionary history of their ancestors.

Fossils. Fossil record does not go back more than 500 million years. When a land animal dies today, its remains are usually destroyed by flesh eaters, or disintegrated by plant roots, soil acids and bacterial action. Similar conditions were present in the past. More exceptionally a dead animal may be buried deep in a deposit of mud or sand where the soft parts will quickly rot away but where the skeleton will be left surrounded by a gradually hardening matrix (Fig. 80a). The bony matter may persist and become recrystalised under heat and pressure and gradually altered into a complex type of mineral in which much of the original constituents of the bone remain. Meanwhile the cavities are, in the course of time, filled by minerals brought in solution, so that the originally porous bone becomes a heavy solid structure. But since the mineral matter filling the cavities is usually of a different nature from that in which the substance of the bone has been transformed, fossil bones when sectioned and studied microscopically, usually show in perfect form the structural details of the original. This fact about the hardening of the fossils was pointed out by the Holy Quran 1400 years ago as follows:

وَقَالُوٓا أَءِذَا كُنَّا عِظَامًا وَّرُفَاتًا ءَإِنَّا لَمَبْعُوثُونَ خَلْقًا جَدِيدًا ۝ قُلْ كُونُوا
حِجَارَةً أَوْ حَدِيدًا ۝ أَوْ خَلْقًا مِّمَّا يَكْبُرُ فِي صُدُورِكُمْ ۚ فَسَيَقُولُونَ
مَن يُعِيدُنَا ۖ قُلِ الَّذِي فَطَرَكُمْ أَوَّلَ مَرَّةٍ ...

(17:49-51)

> "The (non-believers) say: 'What! When we are reduced to bones and dust, shall we really be raised to a new creation?' Say: 'Be you stones or iron or (any Other) created matter which in your minds is hardest'. Then they will say: 'Who will cause us to become a later creation?' Say: 'He Who initiated your creation first'."

Fig. 80-a.—FOSSILIZED BONE (has become part of the rock).

Soft parts of the body are sometimes, though very rarely, preserved. Feathers, ligaments, pieces of skin and hairs, teeth, remains of bones of devoured animals, and even faeces inside the intestines, sometimes become fossilised. Some animals become mummified before burial. Extinct mammoths have been completely preserved in natural 'cold storage' in the Siberian tundras, while woolly rhinoceros have been found pickled in entirety in a waxy material from a Galician oil seep. Fossils may be foot-prints later petrified or they may be remnants of organisms trapped in Arctic ice, amber, quicksand, gravel pits, tarpits and swamps. Or they may be imprints of carbon black on rock, left after the soft parts of the plants and animals are vaporised under heat and pressure.

The strata of sedimentary rocks formed by the processes of erosion and uplift have been described earlier. Fossils formed in different ages are preserved in different layers of the earth. The deeper the layer, the older it is (Fig. 80b). A deep layer today was on the surface in the past ages and the earth's surface today will be a deep layer in future. Fossils preserved in successive layers provide a time picture of evolution. Deep layers are not always visible but occasionally they become exposed in a cross section of the earth produced by an earthquake or a canyon-cutting river. Moreover, erosion gradually wears away top layers and exposes the deeper ones.

Fig. 80-b.—ROCK LAYERS OF DIFFERENT AGES.

Dating. Absolute dating, i.e., age of a fossil in actual years is determined by chemical or radio-active methods. Very excellent clocks lie in the earth's crust. They are radio-active substances. As already mentioned in Chapter IV, certain elements of higher atomic weights undergo spontaneous disintegration. The disintegration rate of these elements is accurately known, as are the end products of disintegration, For example, a given quantity of radium is known to turn into lead in a certain period of time. When radium and lead are found together in one mass within a rock, the whole mass had been presumably radium originally, when the rock was formed. From the relative quantity of radium and lead present today, one can calculate the time required for that much amount of lead to form.

Uranium upon disintegration yields lead of atomic weight 206 (ordinary lead has atomic weight 207): one per cent of uranium disintegrates in 66,000,000 years.

The same principle applies to radiocarbon (carbon-14) dating, or the potassium argon dating.

Fossils themselves often help in fixing the age of a rock layer. If such a layer contains a fossil which on the basis of other evidence is known to be of a definite age, then the whole layer including all other fossils in it is likely to be of the same general age.

Based on data obtained from radio-active and fossil clocks geologists have constructed a geologic time table which indicates the age of successive earth layers and so provides a calendar of the earth's past history. The calendar consists of five successive main divisions, known as Eras. The last three are subdivided in turn into a number of successive periods (Fig 81). The Holy Quran, however, divides the evolutionary period of the earth, as well as of the heavenly bodies, into six eras. The Azoic Era (Era before life began on the earth) is described by the Holy Quran as يومين 'Two Eras':

.... بِالَّذِي خَلَقَ الْأَرْضَ فِي يَوْمَيْنِ ....

"WHO CREATED THE EARTH IN TWO ERAS." ... (41/9)

يَوْمَيْنِ

فَقَضٰهُنَّ سَبْعَ سَمٰوٰتٍ فِي يَوْمَيْنِ ...

"SO HE COMPLETED THEM AS SEVERAL HEAVENS IN TWO ERAS." .... (41/12)

أَرْبَعَةِ أَيَّامٍ

وَجَعَلَ فِيهَا رَوَاسِيَ مِن فَوْقِهَا وَبَارَكَ فِيهَا وَقَدَّرَ فِيهَا أَقْوَاتَهَا فِي أَرْبَعَةِ أَيَّامٍ ...

"HE MADE IN THE EARTH MOUNTAINS STANDING HIGH ABOVE IT AND BESTOWED BLESSINGS ON IT AND MEASURED THEREIN ALL THINGS TO GIVE THEM NOURISHMENT IN DUE PROPORTION IN FOUR ERAS." (41/10)

أَيَّام			ERA		PERIOD	DURATION		BEGINNING DATE
سِتَّةِ أَيَّامٍ	أَرْبَعَةِ أَيَّامٍ	يَوْمُ السَّادِسَة	CAINOZOIC (MODERN LIFE)	QUATERNARY	HOLOCENE	75	20,000 YEARS	20,000 B.C.
					PLEISTOCENE		1	1
				TERTIARY	PLIOCENE		11	12
					MIOCENE		16	28
					OLIGOCENE		11	39
					EOCENE		19	58
					PALEOCENE		17	75
		يَوْمُ الْخَامِسَة	MESOZOIC (MIDDLE LIFE)		CRETACEOUS	130	60	135
					JURRASIC		30	165
					TRIASSIC		40	205
		يَوْمُ الرَّابِعَة	PALAEOZOIC (ANCIENT LIFE)		PERMIAN	300	25	230
					CARBONIFEROUS		50	280
					DEVONIAN		45	325
					SILURIAN		35	360
					ORDOVICIAN		65	425
					CAMBRIAN		80	505
		يَوْمُ الثَّالِثَة	PROTEROZOIC		PRE CAMBRIAN	1500		2000
	يَوْمَيْنِ	يَوْمُ الثَّانِيَة / يَوْمُ الْأُولَى	AZOIC (WITHOUT LIFE)			3000		5000

NUMBERS REFER TO MILLIONS OF YEARS.

THE GEOLOGIC TIMETABLE

Fig.--81

قُلْ أَئِنَّكُمْ لَتَكْفُرُونَ بِالَّذِي خَلَقَ الْأَرْضَ فِي يَوْمَيْنِ وَتَجْعَلُونَ لَهُ
(41:9) أَندَادًا ۚ ذَٰلِكَ رَبُّ الْعَالَمِينَ

"Say : Is it that you deny Him Who created the earth in two Eras, and you make equals to Him Who is the Sustainer of the universe from its initial stage, to the stage of its final destination?"

Rather according to the Holy Quran the evolution of the whole universe including the earth took place in two Eras.

فَقَضٰهُنَّ سَبْعَ سَمٰوَاتٍ فِي يَوْمَيْنِ وَأَوْحٰى فِي كُلِّ سَمَآءٍ أَمْرَهَا ... (41:12)

"So He completed them as several heavens in two Eras and He assigned to each heaven its duty and command."

Thus the immensely long Azoic spans the period from the origin of the earth to the origin of life. As described already, beginning as a whirling globe of interstellar gas, the earth passed through a liquid state to form a solid crust.

At the present state of our knowledge it is difficult to say what these *two eras* are and what exactly has been the sequence of events since the time the whole universe was in a gaseous state which the Holy Quran describes as دخان and Then some bits of it gradually passed through a liquid into a solid state:

ثُمَّ اسْتَوٰى إِلَى السَّمَآءِ وَهِيَ دُخَانٌ ...

(41:11)

"Thus He comprehended in His design the heaven (celestial bodies) and it has been دخان smoke (mixture of gases and suspended matter.*

An alternative explanation, however, is possible. As explained already in Chapter I, there is a period of Divine planning before a creation appears in its manifest form and that the planning is the part of the creation itself. Thus we might say that (two eras) include a Planning Era and an Azoic Era.

The following verses of the Holy Quran lend support to this view:

... إِذَا قَضٰى أَمْرًا فَإِنَّمَا يَقُولُ لَهُ كُنْ فَيَكُونُ ○ (3:46)

"When He has completed His plan, He says to it, 'Be' and it is."

Here the word قضى is significant. It basically means to complete or set aside a certain thing after its completion. The verse indicates that Divine planning is the part of creation itself and that when a planning is completed, the process of creation starts forth-with.

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*The subject has been discussed in more detail in my book entitled, "The Heavens the Earth and the Quran."

At yet another place it is said:

إِنَّ عِدَّةَ الشُّهُوْرِ عِنْدَ اللّٰهِ اثْنَا عَشَرَ شَهْرًا فِيْ كِتٰبِ
اللّٰهِ يَوْمَ خَلَقَ السَّمٰوٰتِ وَالْأَرْضَ ... (9:36)

"The number of months in the sight of Allah is twelve (in a year), so ordained by Him the day He created the heavens and the earth."

Here it is said that the physical creation of the universe took place in one era (يوم) . Accordingly, this يوم which we describe as azoic era in scientific terminology, is distinct from the planning era. The planning era and the azoic era together form 'two eras'. يومين -

The Quran has further divided the time, since life evolved on the earth, into 'four eras':

وَجَعَلَ فِيْهَا رَوَاسِيَ مِنْ فَوْقِهَا وَبٰرَكَ فِيْهَا وَقَدَّرَ فِيْهَآ
أَقْوَاتَهَا فِيْٓ أَرْبَعَةِ أَيَّامٍ ... (41:10)

"He made in the earth mountains standing high above it and bestowed self-perpetuation on the earth and measured therein all things to give them nourishment in due proportion in Four Eras."

It is interesting to note that modern science has also divided the time since life evolved on the earth into Four Eras which are described as (1) Precambrian (2) Palaeozoic (Ancient life) (3) Mesozoic (Middle life) (4) Cainozoic (Modern life).

Of the 5000 million years of the earth's existence, only the last 600 million years or so can be traced with accuracy. Almost nothing is known of the conditions which existed before the earth's crust consolidated and of the 3000 million years which elapsed after the consolidation of the earth's crust. The earliest and most primitive form of life, sea weeds and invertebrate marine creatures, must have been evolving for many million years before their fossilised remains were first preserved in the rocks formed about 600 million years ago. The earliest vertebrates-primitive type of fish-like animals-did not appear for another 100 million years. Land plants first established themselves little more than 400 million years ago and amphibian animals about 350 million years ago. Mammals of which man, through his brain, is the most advanced, date back a little less than 250 million years. Man himself has evolved only within the last million years. The course of evolution has not been smooth and unbroken. Some plants and animals evolved only to die out millions of years later, never to reappear; others have persisted almost unchanged. Major disturbances of the earth's crust caused important changes in geography and climate which in turn influenced the evolution and distribution of plant life. These major disturbances separate the four eras of geological history. The rocks formed during the periods of time between these disturbances are grouped together as distinct systems. Thus the evidence deduced from rocks and fossils reveals not only the general pattern of evolution in plant and animal life, but the development of world's oceans, continents, mountain ranges and rivers; as well as changes in climatic conditions. The transition from the Palaeozoic to the Mesozoic dates the Appalachian revolution, during which the mountain range of that time was built up. By now, these mountains are already greatly reduced by erosion. Similarly the transition between the Mesozoic and Cainozoic was marked by the Larmide revolution which produced the high mountain ranges of today, the Himalayas, the Rockies, the Andes and the Alps.

The Four Eras of Evolution اربعة ايّام

ERA I يوم الثالثة

PRECAMBRIAN

Life began in the Precambrian Era (Fig.82). The fossil record is available, though it is exceedingly fragmentary. The first life cells and three of the present four main groups of organisms, Monera, Protista and Metazoa originated during this Era.

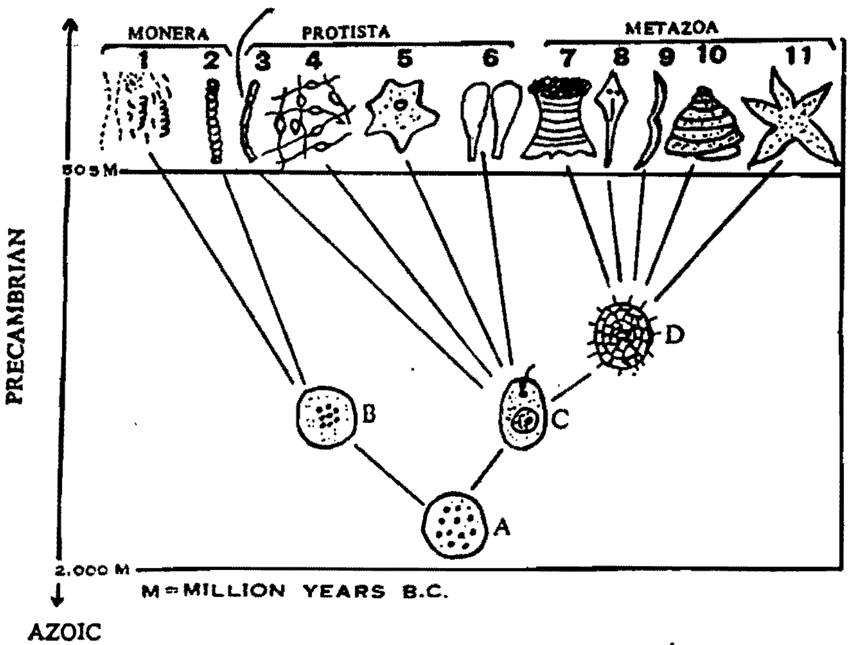

Fig. 82.--PRECAMBRIAN يوم الثالثة

A--first cells. B-first monera. C--first protista. D--first metazoa.

1.--bacteria. 2.--blue-green algae. 3.--fresh-ater green algae.
4.--fungi. 5.--protozoa. 6.--slime molds.
7.--radiata and sponges. 8.--acoelomata. 9.--pseudocoelomata.
10.--schizocoelomata. 11.--enterocoelomata.

Metaphytes evolved later. Monera and Protista descended independently from the very first cells on the Earth. Monera as we know are the unicellular organisms without nuclear membranes. They do not fit into the category of either plants or animals. Bacteria and Blue-greens are the modern representatives of this group. The protista on the other hand can acquire food both by photosynthesis as well as by eating. They move by amoeboid and flagellary locomotion. They thus possess features of both animals and plants. Metaphytes and Metazoa both evolved from ancient protista. They are multicellular and their structure became more and more complex with the passage of time and new organisms evolved through extinction and replacement. Metaphytes are photosynthetic and sessile (non-moving) and are thus plants. Metazoa are non-photosynthetic, they acquire food by eating and are thus animals. Based on reason, not only that life originated in the Precambrian Era, and Monera, Protista and Metazoa evolved from the first cells; all phyla within these three groups had already evolved by the end of Precambrian. As stated above, bacteria and blue-greens evolved from the first Monera. Fresh-water green algae, fungi, protozoa, slime molds evolved from the first Protista which also gave rise to first Metazoa (Multicellular animals).

Five super-phyla of Metazoa exist from the beginning . They are categorised according to their structural pattern. Broadly speaking in every animal the cells are arranged in three groups of layers. Each layer forms a tube one within another. The outermost tube or ectoderm forms the integumentary (skin) system of the body and all its derivatives. The innermost tube or endoderm forms the alimentary system (Digestive system). The middle tube forms all the organs and systems between the body wall and alimentary tract. The following five superphyla evolved from the first metazoa:-

(1) *Sponges and Radiata*:- In these animals mesoderm in the embryo is not well developed or may be absent. Modern representatives of this group include *hydra, jellyfish, sea anemones, corals etc.*

(2) *Acoelomata*:- In these animals mesoderm develops from ectoderm but remains solid. The modern representatives include *flatworms, flukes, tapeworms* etc. The bilaterally symmetrical animals start from this group onwards.

(3) *Pseudocoelomata*:- Here the mesoderm develops in limited regions in the spaces between ectoderm and endoderm. But the body cavity is enclosed by ectoderm on the outside and endoderm on the inside, not by mesoderm Thus the cavity is a false coelom. The representatives of this group include *rotifers* and *marine worms* etc.

(4) *Schizocoelomata*:- Here mesoderm develops from the ectoderm in the larval stage. It later degenerates and new mesoderm develops from the endoderm. This later mesoderm splits into two layers and a true body cavity develops in between them. The group includes *Mollusks (clams, squids, nautiloids etc),*

Annelida (earthworms, leeches etc.), Arthropoda (shrimps, lobsters, crabs, insects, centipedes, millipedes, spiders, scorpions, mites, ticks, horseshoe crabs etc).

(5) *Enterocoelomata*:- Here the mesoderm arises exclusively from endoderm and a true body cavity develops in it. This superphylum includes six phyla, *lamp shells, arrow worms, beard worms, acorn worms, echinoderms and chordata.* The chordata include *tunicates, rancelets and subphylum vertebrata* (animals with vertebral column).

ERA II يومُ الرّابع

PALAEOZOIC (ANCIENT LIFE)

From here onwards the history of earth's evolution can be traced with accuracy, as the fossils are in abundance. The era is further subdivided into *Cambrian, Ordovician, Silurian, Devonian, Carboniferous* and *Permian* periods.

CAMBRIAN AND ORDOVICIAN (Fig. 83)

Cambrian

Geographical conditions. Shallow seas cover much of the earth. 3% of North America submerged. The seas tend to advance on and retreat from the land areas, some of which being a little more than deserts. Climatic conditions are moderately warm and equable.

Life in Sea. All the major groups of invertebrates evolve. Green *Algae* (Sea-weeds) are still the only plants and they provide food for these animals, sponges, coelenterates, brachiopods, bryozoa, echinoderms, mollusks (snails, clams, nautiloids) and tunicates, the dominant and most advanced animals of which there are more than 1000 species, ranging in size from a pinhead to 18 inches. They are all now extinct.

Life on Land. Still there is no life on land.

Ordovician

Geographical Conditions. The seas continue to advance and retreat. There is mountain building in certain parts of the globe. Volcanic eruptions are frequent. The climate is warm and uniform, with no marked climatic zones.

Life in Sea. First vertebrates jawless fishes appear and also the arthropods (joint footed animals) as trilobites and Eurypteroids. Plant life is still sea-weeds.

Life on Land. Still no life on land.

SILURIAN AND DEVONIAN (Fig. 84)

Silurian

Geographical Conditions. The level of seas tends to rise and fall periodically causing regular changes in land areas. New mountain ranges are beginning to form. Less volcanic activity than in Ordovician period. Generally warm and equable climate but exceptionally dry in certain areas.

Life in Sea. New species of vertebrate animals develop in the sea. Appearance of sea scorpions, coiled nautiloids and placoderms (jawed fishes) or heavily armoured animals reaching nine feet in length. Plant life becomes more varied in structure.

Life on Land. First tracheophytes or the vascular plants (rhynia, asteroxylon, hynia and pseudo-sporochnus) appear on land along the seashores, but are still leafless.

Devonian

Geographical Conditions. Land areas increase at the expense of sea. A period of extensive mountain building and volcanic activity. Warm and semi-arid climate in North West Europe and large part of North America, with heavy seasonal rain. Equable conditions prevail elsewhere.

Life in Sea. Rapid evolution of vertebrate animals. Two new types of fishes evolved from early placoderms-the cartilage fishes and the bony fishes. The later radiated into three main subgroups-paleoniscoid fishes, the lung fishes and the lobe finned fishes. Primitive sharks, measuring up to 20 feet appear. This period is thus known as Age of Fish. By the end of this period first amphibious animals have come into existence.

Life on Land. Earth begins to look green, as later psilopsids, lycopsids and sphenopsids-plants with roots, stems and leaves evolve. They range from small herb-like growths to 100 feet or more in height. For example, lycopsids or giant club mosses being up to 120 feet high and sphenopsids being up to 100 feet high. Pteropsids (ferns) evolve by the end of this period. With land plants to feed on, the first invertebrate animals adapt themselves to life on land. They include millipedes (segmented animals), mites, ticks, spiders and wingless insects.

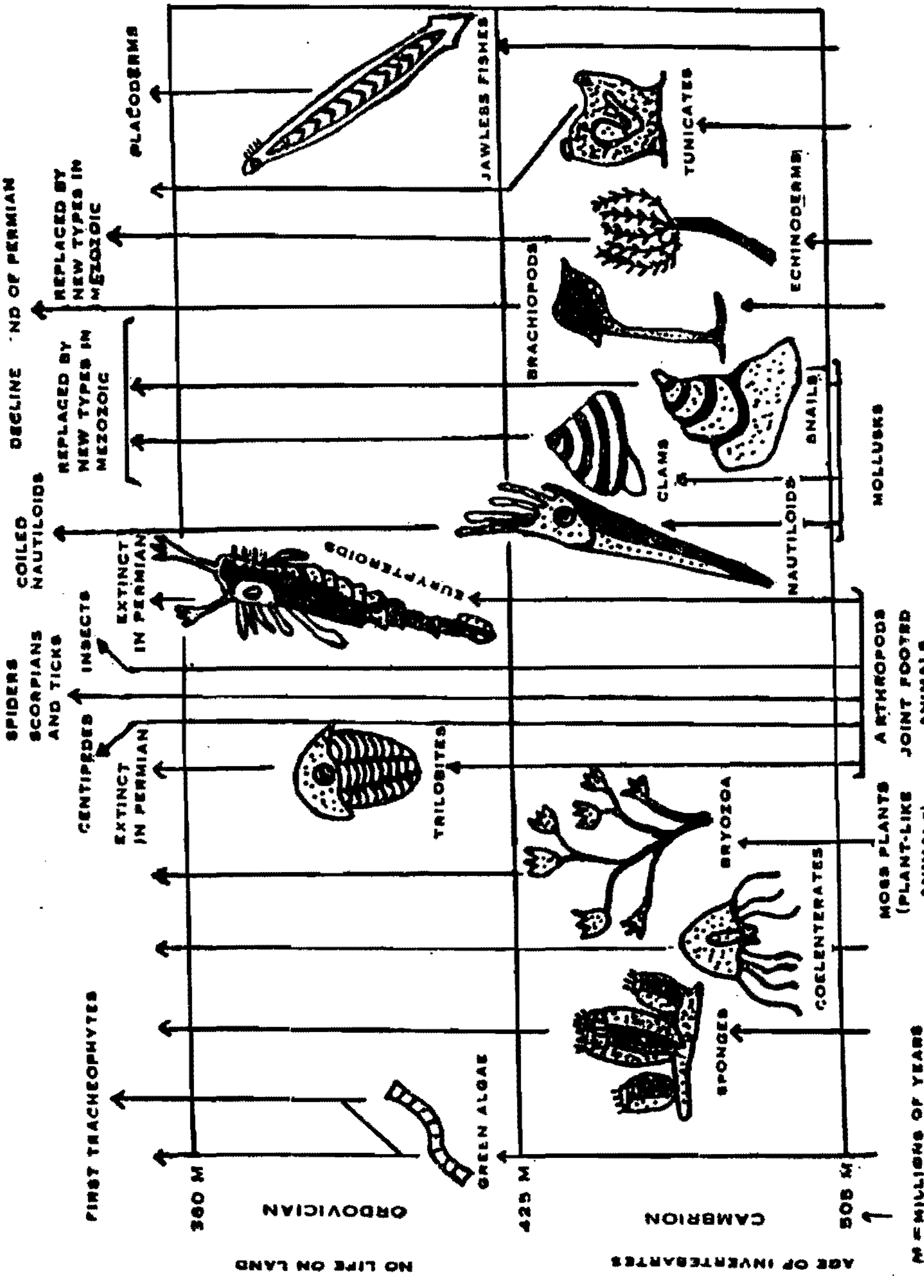

Fig. 83.-- PALAEOZOIC ERA يوم الرابعة (Part 1).

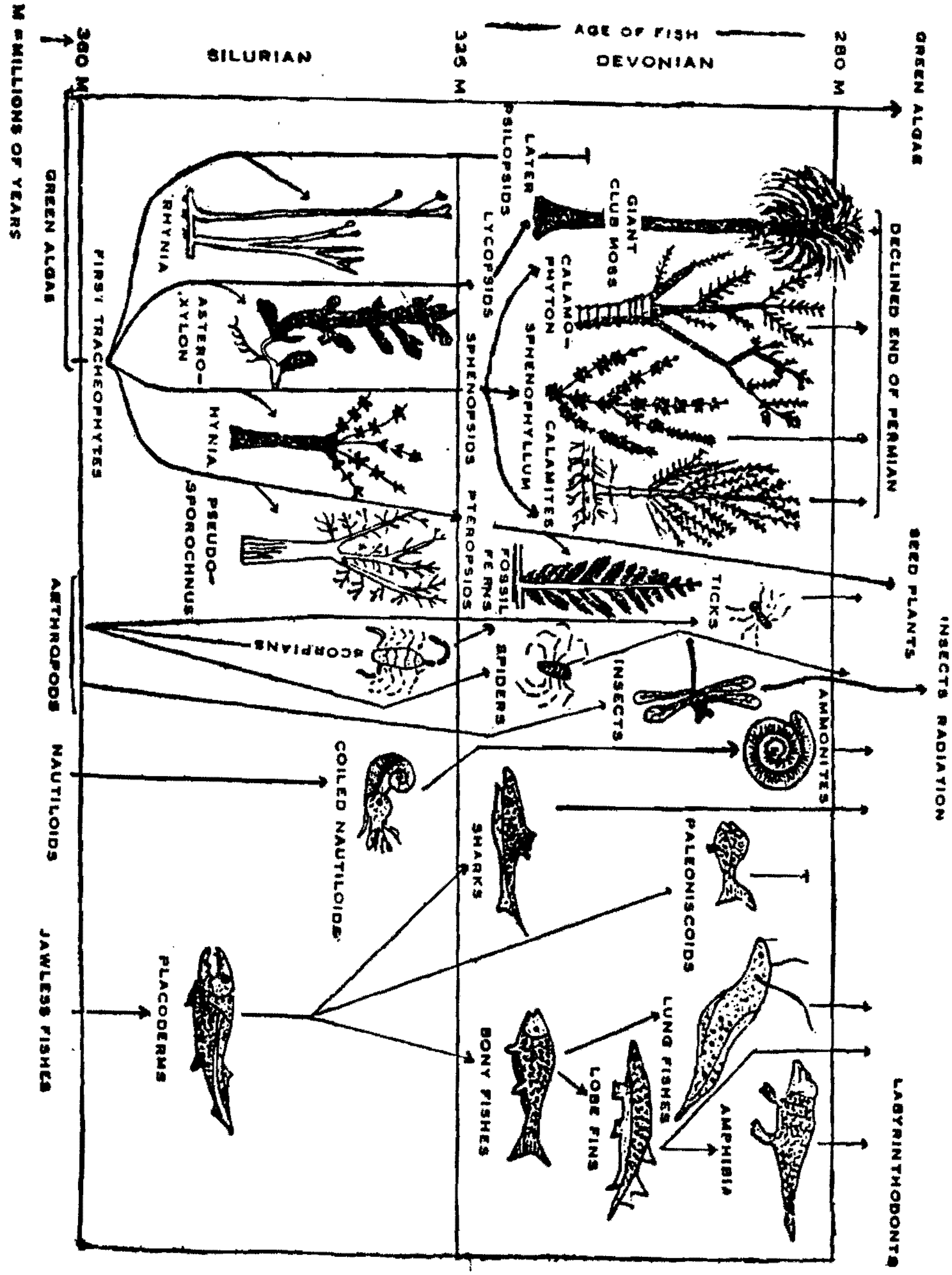

Fig. 84.-- PALAEOZOIC ERA يوم الرابعة (Part 2).

CARBONIFEROUS AND PERMIAN (Fig. 85)

Carboniferous

Geographical Conditions. Shallow seas wide spread in early period. Most of Europe and large part of Russia under water. Later sea beds begin to rise, land areas sink producing brackish swamps over most of Europe and North America. Chief coal forming period particularly in Northern Hemisphere. Partly rotted vegetation in forest swamp slowly accumulates as peat and later forms coal. The land climate is extremely dry during the period but in some regions it is warm and moist enough to encourage dense vegetation.

Life in Sea. Amphibious creatures continue to develop and give rise to clumsy labyrinthodonts. Living in swamp-land on the edges of lakes, they are small salamander-like animals to begin with, but reach sizes up to 15 feet by the end of this period. Marine life, both plant and animal, abounds in many varieties.

Life on Land. Carboniferous is known as age of seedferns and amphibia. Fossil ferns and fossil conifers, giant evergreen trees, reaching heights of over 100 feet flourish in the tropical swamp of the period which knows no seasonal changes in temperature. First bryophytes or moss plants appear. Certain species of insects develop wings.

Permian

Geographical Conditions. A period of considerable earth movements. Lofty mountains form in Europe, Asia and Eastern U.S.A. Contrasting climatic conditions, mainly arid in Northern Hemisphere, with occasional warm and humid zones, but ice-age conditions cover much of the Southern Hemisphere.

Life in Sea. This period marks the end of the dominance by marine creatures as animal and plant life on land increases.

Life on Land. As seasonal differences of climate and temperature develop, evergreen plants begin to decrease in number and deciduous plants, able to withstand periods of drought and frost appear. Creatures capable of living on land increase in number and variety, ending the period of domination by marine creatures. As in the sea, however, animal life is predominantly reptilian. Cotylosaurs or stem reptiles evolved from Ancestral Labyrinthodonts. A great variety of insects begins to emerge.

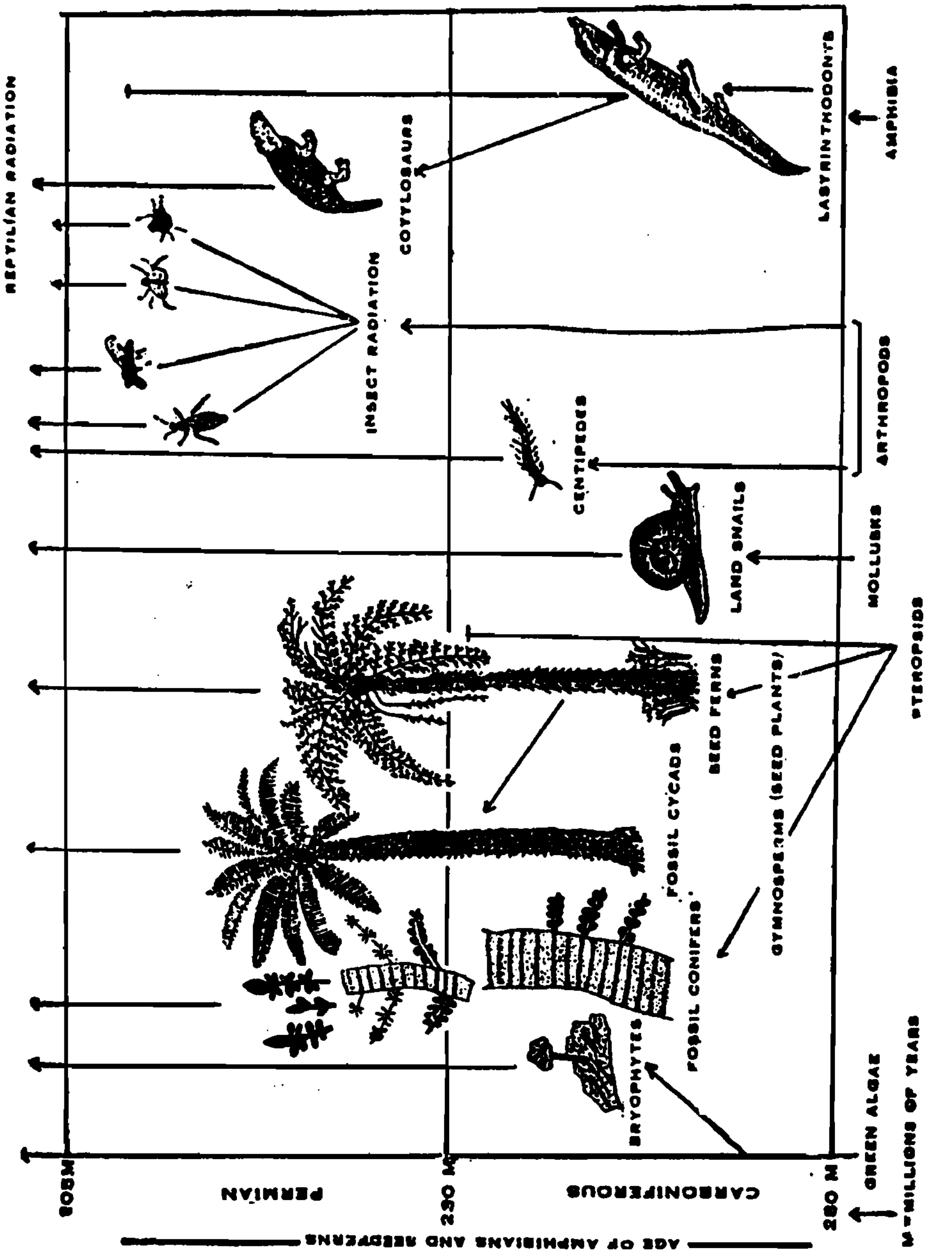

Fig. 85.– PALAEOZOIC ERA يوم الرابعة (Part 3).

ERA III يوم الخامسة

MESOZOIC (MIDDLE LIFE)

This is again subdivided into three periods Triassic, Jurassic, Cretaceous.

Triassic.

Geographical Conditions. Deserts and shrub-covered mountains cover most of the earth's land area. Formation of marl and sand-stone deposits in the warm seas. Hot dry conditions prevail almost everywhere. Climate becomes wetter towards the end of this period.

Vegetation. Arid conditions in the Northern Hemisphere discourage the development of plant life at the beginning of the period. Later wetter conditions stimulate the growth of conifers, cycads and ferns. Mesozoic Era as a whole is called 'Age of gymnosperms' (plants having seeds unprotected by seed vessels). Triassic and jurassic periods within this era are called age of cycads and cretaceous as the age of conifers.

Jurassic

Geographical Conditions. The seas advance again. Most land areas consist of forests or swampy plains with lakes and meandering rivers. The high mountains already eroded by the arid climate of the previous period are reduced to low hills by the wet conditions. Much of Asia and Europe is invaded by sea. A period marked by the formation of limestone. The climate is predominantly mild, becoming subtropical in some regions later in the period. There is a sumcient rainfall to support luxurious vegetation.

Vegetation. Conifers, cycads, ferns and tree-ferns continue to flourish. Some cycads have flower cones the first step in the evolution of flowers.

Cretaceous

Geographical Conditions. Land areas bordering the sea consist of far-reaching swamps. The rivers flow slowly and form enormous deltas. Wide-spread deposits of chalk. Period of major mountain building. The climate continues to be mild, causing vegetation to grow abundantly as far north as Greenland, though part of Australia appears to be covered by glaciers.

Vegetation. A mild climate with alternating seasons, a feature of this period, encourages the growth of deciduous trees as fig, magnolia, poplar, plane. The parallel evolution of insects and nectar-bearing flowers encourages the spread of flowering plants.

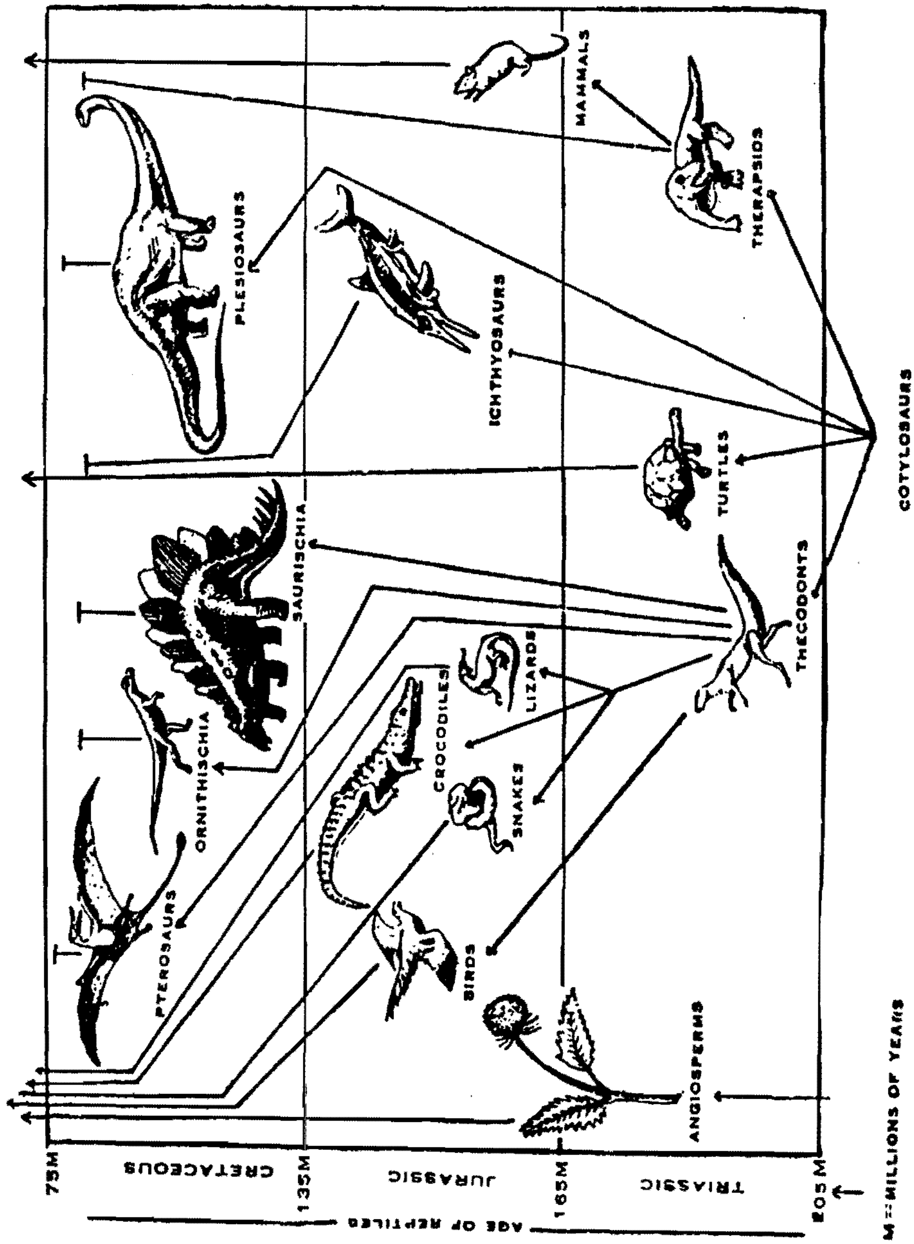

Fig. 86.--MESOZOIC ERA يوم الخامسة

Several major evolutionary events occurred during the Mesozoic Era. As has been pointed out, the flowering plants arose during the Jurassic and underwent an explosive expansion during the Cretaceous, which established them as the dominant land plants from then on. In parallel with this insects re-radiated enormously. An equally extensive radiation occurred among the bony fish. These became the dominant aquatic animals, a status they still retain today. However, the most spectacular Mesozoic event was the expansion of reptiles. These animals evolved not only many different terrestrial ways of life but also invaded the water and the air. At the beginning of Mesozoic, the following five major reptilian stocks were in existence (Fig. 86). All evolved from the Cotylosaurs during Permian as follows:-

(1) *Thecodonts*. Which evolved short fore limbs and which in turn gave rise to ancestral Birds; the ancestors of the modern Crocodiles, Lizards and Snakes; the flying Pterosaurs; and Dinosaurs. The first bird Archeopteryx (Fig. 79) evolved feathers from scales but retained many reptilian characteristics such as teeth, solid bones and long jointed tail. Pterosaurs developed wings made of skin stretched between body and fingers (Fig. 87). Some of the Dinosaurs were of enormous size. One group Brontosaurus was the largest land animal of all times. One Diploducus had length 87½ feet and wight 35 tons. Dinosaurs were herbivorous and lived in swamps and marshes. One group, Tyrannosaurus (Fig. 78) was the fiercest land carnivore of all times.

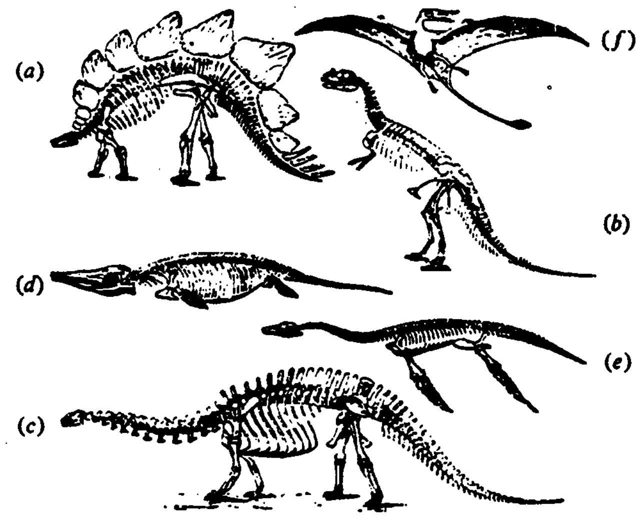

Fig. 87.--MESOZOIC REPTILES.

(a) Dinosaur (Stegosaurus).--18 feet long.
(b) Dinosaur (Ceratosaurus).
(c) Dinosaur (Brontosaurus).--length 87½ feet, weight 35 tons.
(d) Ichthyosaur-marine, 30 feet long.
(e) Plesiosaur.--marine, length up to 50 feet
(f) Pterosaur.--flying reptile.

(2) The second replitian stock was ancestral to modern turtles. (Fig. 86)

(3-4) The third and fourth groups produced two kinds of marine reptiles, Icthyosaurs and Plesiosaurs.

(5) The fifth stock was of therapsids or mammal-like reptiles, which included the ancestors of true mammals.

The Dinosaurs on the land, Icthyosaurs and Plesiosaurs in the oceans and Pterosaurs in the air reigned supreme on earth for 130 million years. Birds and mammals, though evolved during the Mesozoic, remained small and inconspicuous.

With the close of Cretaceous, virtually all the reptiles became extinct. Today this class is represented only by the turtles, crocodiles, lizards and snakes.

ERA IV يوم السادسة

CAINOZIOC (Modern Life)

This Era started about 75 million years ago and is again subdivided into periods as follows:-

Paleocene and Eocene

Geographical Conditions. Seas advance once again. Tropical vegetation, like that in the present-day Malaya, flourishes in Southern England. Mountain ranges which began to form in the cretaceous period continue to grow. Volcanic activity leads to the formation of Atlantic and Indian oceans, and causes vast amount of lava to be deposited in area as far as apart as the Arctic, Scotland and Ireland, and Southern India. Tropical conditions are more widespread than today but glaciers exit on high mountain ranges in Western North America.

Life in Sea. Marine reptiles become extinct, but two groups of mammals -- early whales and sea-cows--begin to adapt themselves to life in the sea. Most species of fish in the ocean take on the shape and form we know today.

Life on Land. In Cainozoic as a whole Gymnosperms gradually decrease and Angiosperms (plants in which ovules are enclosed in ovaries -- Flowering plants) increase. It is an 'age of Angiosperms. Thus in Eocene flowering plants, including deciduous trees, become dominant. The warm climatic zone which stretches right up to Greenland, allows plums to grow in the region of Bournemouth and Malayan type jungles in the region of London. Many varieties of modern mammals come into existence, such as the ancestors of the elephants, the rhinoceros, the horse, the pig and the cattle. Giant reptiles have disappeared, but crocodiles, turtles and land tortoises evolve, as do all groups of insects that we know today. Primitive monkeys and gibbons appear in Burma.

Oligocene

Geographical Conditions. Throughout the period the land mass grows at the expense of the sea. Extensive movements of the earth's crust take place in the Americas and in Europe. The Alps begin to form. Warm temperate conditions continue, but part of the land mass experiences a cycle of cooler winters.

Life in Sea. A period in which new species of crabs, mussels and snails evolve.

Life on Land. As a cooler climate affects some parts of the world, forests dwindle and grasslands spread, leading to an increase in grass-eating mammals. The ancestors of modern cats, dogs and bears evolve. The number of plant-eating animals increases; such as small elephants with short trunks and tusks in both upper and lower jaws, hoofed animals with odd number of toes and giant rhinoceros. A tail-less primitive ape appears.

Miocene

Geographical Condition. Powerful earth movements lead to a further retreat of the sea. The Mediterranean becomes virtually a land-locked ocean. The European and Asian land masses are finally joined together. Increased rainfall leads to intensive erosion in some parts. Further powerful movements of the earth's crust complete formation of the Himalayas. There is much volcanic activity. Climates tend to become more varied, dry and arid in some regions; cool and wet in others.

Life in Sea. Bony fishes continue to increase in variety. Sharks become particularly abundant during this period and grow to enormous sizes, measuring over 60 feet in length and having teeth 6 inches long.

Life on Land. Mild damp climate in Europe and North America stimulates development of deciduous woods, maple, oak and poplar. Cedars and sequoias are established on high grounds. The great plains of North America become covered with prairie grasses. Proconsul, a primitive anthropoid ape, living in Central Africa, migrates to Asia and Europe. A gibbon-like ape known as *Pliopithecus* is common in the forests of Southern Europe. Elephants steadily increasing in size, spread from Africa in to Europe, Asia and North America. Long legged water birds, ducks and pelicans live in rivers and lakes. Primitive penguins, some as tall as man, live in Antarctica.

Pliocene

Geographical Conditions. Continents and oceans begin to take on their present form. Land subsidence leads to formation of the North Sea, the Black and

Caspian Seas, and the Sea of Aral. Formation of mountain ranges continues, though on a reduced scale. Climatic conditions are much like today but with a broader temperate zone.

Life in Sea. Giant sharks become extinct, as did creatures that grew to a great size in other periods. Marine life, both plant and animal, becomes much as it is today.

Life on Land. Some plants of this period, such as the maiden-hair tree, die out in Europe but survive in China and North America. The number of mammal species decline with the notable exception of Hominids or manlike apes, which continue to develop and thrive. These apes came to include not only the forest dwellers but also species like *Australopithecus*, which walk upright in open country. Elephants also thrive.

Pleistocene

Geographical Conditions. Ice sheets and glaciers cover most of Europe, America, Antarctica and the Himalayas. The ice sheets melt periodically, thus raising the sea level, and the land masses of Europe and North America, which had been pressed down by the enormous weight of the ice, begin to rise. Melting ice forms the great lakes of North America, of Switzerland, of North Italy and of Great Britain. Landscape begins to take on the present-day form and appearance. It is a period of abnormal and extreme climatic change.

Life in Sea. Marine life much as it is today.

Life on Land. Succeeding ice ages cause many plants in Europe to perish, leaving only border varieties such as oak, willow, poplar, elm,. hawthorn. In America and Asia, vegetation seeking warmer climate, encounters no sea or mountain barriers, and more plants survive. Hominids (or manlike types) develop enough intelligence to make stone implements for cutting up animals they have killed, probably originating in Africa, primitive man spreads to Asia and Europe. Alternating ice ages and warm periods change the migration habits of other animals. True elephants, horses and oxen first appear.

Holocene

Geographical Conditions. The ice continues to retreat, causing the sea level to rise further. Britain joined to Europe during the glacial period, is cut off from the Continent. Landscape much as we see it today. Climatic conditions gradually become more equable. In North Africa and Middle East increasing dryness produces deserts.

Life in Sea. Marine life much as it is today.

Life on Land. With the retreat of ice and the arrival of warmer summers, forests begin to spread all over Europe. Tundra vegetation (dwarf shrubs) is replaced by birch and pine, followed by hazal and then by oak and elder. Man learns to domesticate animals and cultivate plants.

The *Cainozoic* Era as a whole began with the Larmide revolution which produced the present high mountain ranges and led to progressively cooler climates. These climatic changes culminated in the four ice ages in the Pleistocene period. The radiation of Mammals and Birds came to be the main feature of animal evolution during the Cainozoic Era. Mammals on the land replaced the Dinosaurs; aquatic mammals took the place of Icthyosaurs and Plesiosaurs; and bats but more especially birds, gained the air left free by Pterosaurs. The Era is thus known as the age of *mammals and birds*.

BIRDS

Birds are very much advanced over all lower animals in having (1) Insulated body covering (2) Complete separation of arterial and venous blood (3) Regulated body temperature (4) High rate of metabolism (5) Ability to fly (6) Highly developed voice, hearing and sight and (7) Specialised care for young. In all these features they stand above the reptiles and are comparable only to mammals from which they differ notably in the type of body covering, in the ability to fly, and in the manner of reproduction.

Distribution. Birds occupy all continents, the seas and most islands; penetrating the Arctic[1] to beyond 80°N and the Antarctic;[2] and occur from sea level to above timberline on mountains, even to above 20,000 feet on Mount Everest. Though they are able to fly, they conform to the laws of animal distribution, each species occupying a definite geographic range and particular kind of habitat.

Activity. Birds are active throughout the year on account of being warm blooded.

Voice. Most birds can utter calls and songs. Some species have only fixed calls but most song-birds have definite songs. Crows and Jays use various notes to convey different 'ideas' to others of their species. Parrots, Mynas, Magpies[3] and mocking birds have the power of mimicry. The average pitch in songs of 59 passarine species, studied by Brand, is 4280 cycles per second, i.e., above the highest note (C^7) on the piano. Bird notes serve (1) to assemble gregarious (living in flocks) species (2) To advertise nesting territory and attract mates (3) For directional calls between parents and the young and (4) to warn in the event of danger.

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[1]ARCTIC--Of the north Pole. Circle the parallel of 66°-32′N; north of which the sun does not rise at mid winter or set at mid summer. Comprises of both land and sea.

[2]ANTARCTIC-Of the South Pole. Circle the parallel of 66°-32′S; South of Which the sun does not rise at mid winter or set at mid summer.

[3]MAGPIE-A European bird with long pointed tail, and black and white plumage.

Migration. There are well over 800 known and named species of birds and great many of them are migratory. Despite all dangers of storms, droughts, and of man himself, millions of birds undertake twice yearly journeys thousands of miles long, over the continents and oceans to reach their breeding areas. Before migrating, birds lay in stores of energy in the form of fat deposits beneath the skin; some species are thus able to fly continuously for several days. Migratory birds navigate with phenomenal accuracy. The Pacific Golden Plover, which breeds in the extreme West of Alaska and in eastern Siberia, crosses the Pacific to make pin-point arrivals on such small islands as Hawaii. In one experiment, a Manx Sheerwater, captured and ringed in Wales was flown to Boston, U.S.A. and released there. Twelve and half days later it arrived home, having crossed 3000 miles of trackless ocean.

The Holy Quran points out that the light of Divine guidance prevails over the entire universe. Every object living or non-living functions in perfect harmony and obediently follows the way of life prescribed for it by the Creator. Look at the birds, how they carry out their daily routine and travel thousands of miles without missing their route. So should mankind who is bestowed with the unique faculty of "freedom of choice" turn towards his Salat or the way of life prescribed for him by Allah.

أَلَمْ تَرَ أَنَّ اللّٰهَ يُسَبِّحُ لَهٗ مَنْ فِي السَّمٰوٰتِ وَالْأَرْضِ وَالطَّيْرُ صٰٓفّٰتٍ ؕ كُلٌّ
قَدْ عَلِمَ صَلَاتَهٗ وَتَسْبِيحَهٗ ؕ وَاللّٰهُ عَلِيمٌۢ بِمَا يَفْعَلُونَ ۝

(24:41)

> "Do you not see that every individual constituent of the universe steadfastly and obediently carries out the duty assigned to it by the Diving programme, and the birds with wings outspread? Each one knows his *Salat*, the way of life prescribed for him; and his Tasbih, the sphere of activity. Every bit of action in the universe is in the knowledge of Allah."

Feathers are a unique and most conspicuous characteristic of birds. They aid in flight, as well clothe and insulate their bodies. They are epidermal structures which provide light weight, flexible but resistant body covering, with innumerable dead air spaces useful as insulation. They protect the skin from wear; and the thin flat and overlapping wing and tail feathers form surfaces to support the bird in flight.

How does a birdy fly? In order to understand the underlying principle in flight, let us first discuss the forces which hold a kite, flying in the air. It is acted on by three forces:-

(1) Its own weight mg acting downwards.

(2) T, the tension of the string also acting downwards along the direction of the string. T, can be resolved into two components (a) Force of the string pulling the kite vertically downwards (b) Force of the string pulling the kite horizontally backwards.

(3) The pressure P of the air, which again can be resolved into two components. One pushing the kite in the forward horizontal direction called the Drift and the other in the vertically upward direction called the Lift. If lift is equal to the weight of the kite and downward pull of the string, and drift is equal to the backward pull of the string, all the different forces cancel one another and the kite will remain in equilibrium. On the other hand if the lift is greater than the weight of the kite and the downward pull of the string, the kite will rise up, while if the drift is greater than the backward pull of the string, it will move forwards. If the lift is less than the weight of kite and downward pull of the string, the kite slowly comes down. The jerk given to kite increases the pressure of the wind and therefore the lift. This helps the kite to rise to a higher altitude.

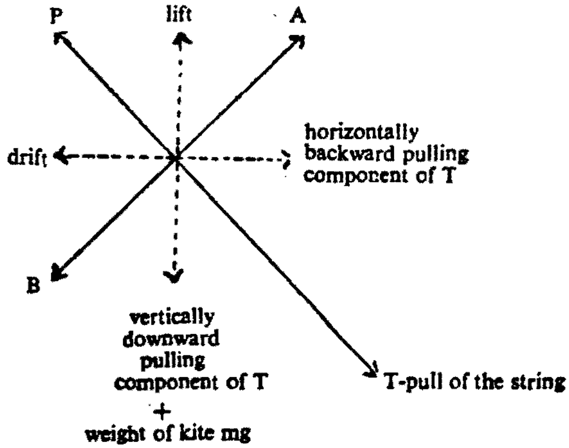


Fig. 88–THE PRINCIPLE OF KITE-FLYING.

The same principle applies to the flight of a bird, with the difference that here the pull of the string is absent. Moreover a bird is not passive like a kite. It is an active living body where the movements are controlled by the wing muscles. Here the weight of the body pulls vertically downwards while the pressure of the wind produces the lift and the drift. The pressure of the wind is produced by vigorous downward strokes of the wings, and the various tilting and banking movements aid in altering the manner of flight. The tail serves as a rudder in flight and as a counterbalance in perching. Male birds of many species also display their tails in courting, as far instance the peacock.

The Holy Quran says:

أَوَلَمْ يَرَوْا إِلَى الطَّيْرِ فَوْقَهُمْ صٰفّٰتٍ وَّيَقْبِضْنَ ۚ مَا يُمْسِكُهُنَّ إِلَّا الرَّحْمٰنُ ۚ
إِنَّهُ بِكُلِّ شَيْءٍ بَصِيرٌ ٥

(67:19)

> "Do they not observe the birds above them, spreading their wings and folding them in, nothing can uphold them except the law of One Who provides means of nourishment, within a specified pattern and without return? He keeps an eye over all things."

Again it is said:

أَلَمْ يَرَوْا إِلَى الطَّيْرِ مُسَخَّرٰتٍ فِي جَوِّ السَّمَآءِ ۭ مَا يُمْسِكُهُنَّ إِلَّا اللّٰهُ ۭ إِنَّ
فِي ذٰلِكَ لَاٰيٰتٍ لِّقَوْمٍ يُّؤْمِنُوْنَ ۝

(16:79)

> "Do they not look at the birds, held poised in the midst of the sky? Nothing holds them but the law of Allah. Verily in this are signs for those who believe".

The feet in birds are used for running or climbing, for support of body at rest, for arranging nest materials and in some species for handling food and for offence.

The birds are very small in size as compared with the largest mammals and fishes. The largest living birds include the ostrich of Africa which stands 7 feet tall and weighs 300 pounds or more, and the great condors of the Americas with wingspreads up to 10 feet; the smallest is the humming bird of Cuba, $2\frac{1}{2}$ inches long and weighing about $^1/_{10}$ ounces.

MAMMALS

The class Mammalia includes the highest forms of life on earth, culminating in man. Mammals are warm blooded, lung breathing hairy vertebrates. Their skin contains sweat and sebaceous glands; jaws are usually with differentiated teeth, in sockets; limbs are adapted for walking, climbing, burrowing, swimming or flying; toes are with claws, nails or hoofs; body temperature is regulated; heart is four-chambered; lungs are large and elastic; there is a diaphragm between thoracic and abdominal cavities; fertilisation is internal; eggs are small or minute. The young of all but lowest types undergo development before birth by getting nourishment from the mother's blood through placenta. All are nourished after birth by milk secreted from mammary glands. On the basis of their method of reproduction three subclasses came into existence, including a total of some two dozen independent orders (Fig. 89).

The *subclasses* are:-

(1) Prototheria or primitive oviparous monotremes (egg-laying mammals).

(2) Metatheria or pouched viviparous Marsupials.

(3) Eutheria or the placentals.

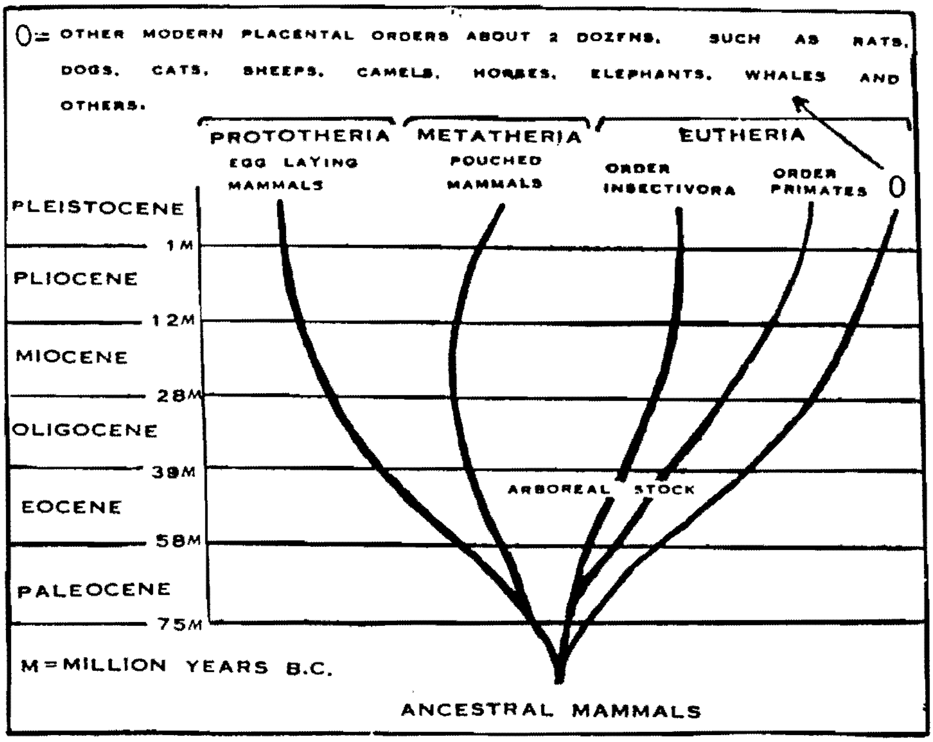


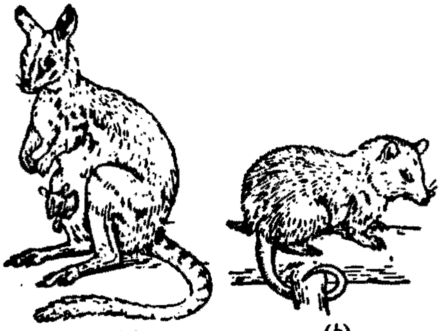
Fig. 89--THE MAMMALIAN RADIATION.

Prototheria. Although the females are egg-laying, the young when hatched are nourished by milk. There are only three species each about the size of a rabbit. Duck-billed Platypus is the most familiar living representative (Fig. 90). Spiny anteaters, Echidna and Pro-echidna are others.

Fig. 90.—THE DUCK-BILLED PLATYPUS.

Metatheria (Fig. 91). The pouched mammals or Marsupials, like Kangaroo and Opossum occur today chiefly in Australia and neighbouring islands. Their reproduction is unique. The eggs hatch within the mothers' body where development proceeds for a short time, nourishment being provided through an atypical very primitive placenta. Then the young are born in a very immature condition and make their way to a pouch on the abdomen of the mother. Here they attach themselves to the teats of mammary glands and are nourished by milk. The pouch serves as a refuge, even after the young are well developed.

Eutheria. Eutheria or Placentals comprise all the rest of the mammals from lowly insectivores such as hedge-hog to man. Cats, dogs, lions, sheep, camels, horses, elephants, whales, dolphins, bats and many others come under this category. All nourish their young before birth by means of a highly complex placenta which



(*a*) (*b*)
Fig. 91.—MARSUPIALS (pouched animals).
(*a*) KANGAROO. (*b*) OPOSSUM.

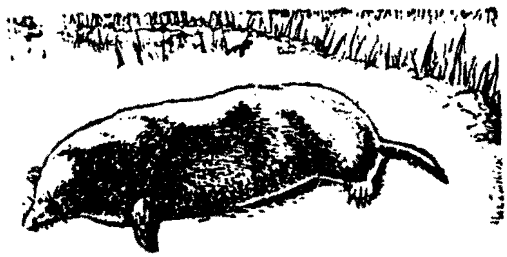


Fig. 92.—MOLE.

(*a*)


(*b*)


Fig. 93.—(*a*) SHREW.
(*b*) ARBOREAL SQUIRREL SHREW
(the link between insectivore mammals and primates).

makes possible the protracted development of the embryo under ideal conditions for nutrition and protection within the mother's body. Each mammalian line descended from the common ancestral stock and exploited a particular way of life available at the time. They adapted to nearly all types of environments and modes of life. One mammalian line is of particular interest, for it eventually led to man. Its members took to trees, which then still formed vast forests, and adapted to an *Arboreal life.*

This line produced two major sublines, the order Insectivora and the order Primates. Most modern insect-eating mammals, particularly the moles (Fig. 92) and the hedgehogs are clearly distinct from modern primates. But some of the shrews (Fig.93) now living are exceedingly like insectivores on the one hand and like primitive living primates on the other. Fossil data similarly supports the view that Insectivore mammals and Primates are closely related, through a common shrew-like arboreal insect-eating ancestor (Fig. 93).

THE PRIMATE RADIATION

The first distinct primates that evolved from this insect-eating ancestor during the Paleocene may be referred to as the early Prosimians. They were small and shrew-like in appearance, with a fairly long snout and a long bushy tail. They were also active and swift-footed, an important adaptation in a life among the tree-tops. They possessed good eyes and good neuromuscular coordination. Of the many lines which radiated from the early prosimians during the Paleocene, four major ones survive today (Fig. 94).

Modern Prosimians. Of these four lines, one retained the prosimian characteristics and gave rise to a number of sublines, from which the *modern* Prosimians came into existence. The modern prosimians include *Lemurs* (Fig. 95) and *Aye Ayes* (Fig. 96) found today largely on the island of Madagascar. These animals still possess long snouts, and long tails, not prehensile. Second toe is with claw, others are with nails. Nails are a specific adaptation to arboreal life, for they interfere less with movements along tree branches than long claws.

The modern Prosimians also include *Tarsiers* (Fig. 97) of South Asia and Indonesia. They are nocturnal tree living form. Tarsal regions of feet are long, only 2nd and 3rd toes have claws. Fingers are well developed and tips of all digits have rounded pads. Tail, long rat-like, not prehensile. The snout has receded considerably and a fairly well-defined face has appeared. Ears are large and thin. The eyes which in lemurs are still more or less on the sides have moved well into the face and are protruding. As a result, tarsiers possess sterioscopic vision. i.e., they can focus on one point with both eyes and they have efficient depth perception. These features are additional adaptations to life on tree tops. In ground animals, such as horse for example, the eyes are located on the sides. This is of great advantage to the animal as he can see things around him even while grazing. On the other hand it is essential for a tree dweller to look ahead while moving fast among the branches of a tree, in order to retain his balance. To look on either side is less important for him. While visual apparatus is advanced, the sense of smell is proportionately reduced. Tarsiers are suggested to be a relic of a primitive group from which apes have descended, as evidenced by their placental structure.

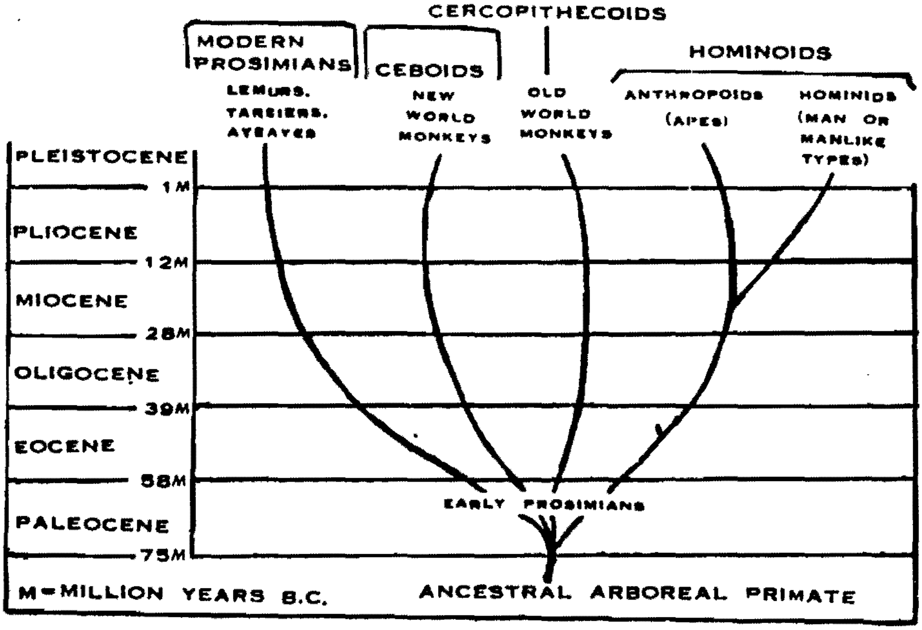


Fig. 94.—PRIMATE RADIATION.

Fig. 95.—LEMUR.

Fig. 96.—AYE-AYE.

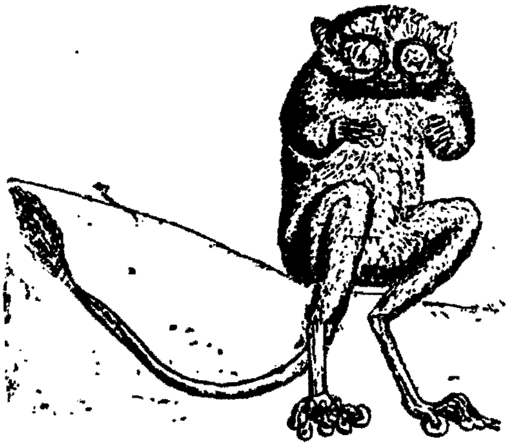


Fig. 97.—TARSIER.

New World Monkeys. The second of the main groups that descended from the early Prosimians consists of *ceboids* or the *New World Monkeys.* They attained their present diversity during the Oligocene and Miocne. Today, they are confined to South and Central America. They are characterised by wide flat interval between nostrils, no cheek pouches and by long tails which are used as fifth limb (Fig. 98).

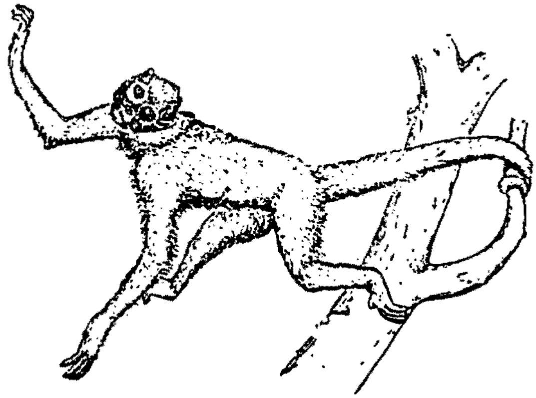


Fig. 98.—NEW WORLD MONKEY.

Old World Monkeys. The third main group that evolved from early prosimians consist of *cercopithecoids* or *old world monkeys.* They too radiated during the Oligocene and Miocene and are found today in Africa and Asia. They possess tails but they are not used as limbs (Fig. 99). Nostrils directed downwards, with a narrow space in between. There are ischial tuberosities on buttocks with calloused exposed skin.

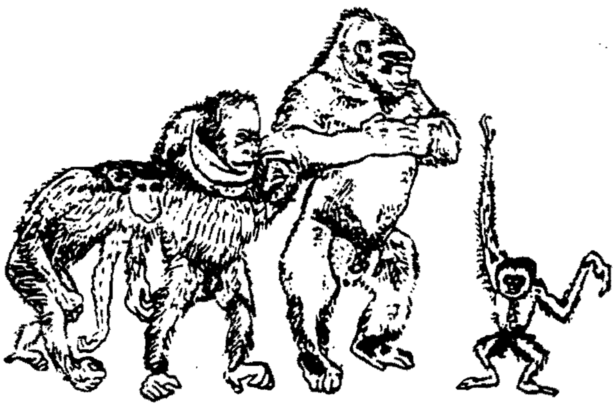
Fig. 99.—OLD WORLD MONKEY.
(rhesus monkey)

Characteristics. In both groups of monkeys, the structural and functional developments have advanced very much further, for adaptation to tree living. A monkey possesses opposable thumbs so that he can grip tree branches very firmly. In animals like horse or bullock the movement of limbs is mainly anteroposterior (back and forth) and lateral play is very little. This is an energy-saving feature while running. But in the case of tree dwellers freely movable limbs are required. Thus in monkey ball and socket joints with movement of circumduction have developed, so that limbs could be rotated freely all round. The face is well developed. Vision is stereoscopic. With further development of coordination between eyes and limbs, intelligence has much increased. The central nervous system has become very much advanced. The sensory and motor areas of brain have increased with the development of finer senses and complex muscular movements. The optic lobes are enlarged. The idea of time and space has become much more accurate.

Hominoids. Similar characteristics, but developed very much further than in the monkeys, are present in the fourth group of living primates called *Hominoids.* They evolved independently from the Paleocene Prosimians. During early Miocene the Hominoids branched into two main sublines:--(1) Anthropoids or Apes (2) Hominids, the family of man or manlike types.

Characteristics of Hominoids. Absence of external tail, increase in body size over prosimians, still further enlargement of brain with more elaborated functions.

Anthropoids or Apes. Today they are represented by four genera: Chimpanzees, Orangutans, Gorillas and Gibbons (Fig. 100). The skeleton is close to the human type. Chest is broad as compared with monkeys and hips have expanded. With the increase in size, normal four-footed progression in the trees has become increasingly impossible and the members of the group normally progress by swinging from one branch to another with the body suspended from the hands.



(*a*) (*b*) (*c*) (*d*)

Fig. 100.--APES.

(*a*) Chimpanzee. (*b*) Orangutan. (c) Gorilla. (*d*) Gibbon.

Smallest and most primitive of this group are the *Gibbons* of Malaya. Body slender, limbs long, height to 3 feet, travels easily through trees, but can walk erect with arms as balancers. He is, however, entirely a tree dweller and with his long arms which can reach the ground in erect position, is a very clever acrobat. Voice is powerful. Brain capacity is 90 cubic centimeters.

Orangutan (man of woods) of Sumatra and Borneo lives in swampy forests. Face flattish, 54 inches tall, hairs long and reddish. Old males are often with beard. He is still a true arboreal. Arms are somewhat shorter reaching only the ankles. Skull hightopped. Brain capacity is 550 cubic centimeters.

The highest living apes are *Chimpanzees* and *Gorillas* of tropical Africa. Chimpanzee is above 5 feet in height and the male gorillas more than 6 feet, with a weight 600 pounds. The arms of Chimpanzee reach a bit below the knees and those of gorilla not quite so far. Brain capacity in both is about 500-600 cubic centimeters.

The group is as a whole fundamentally tree-dweller like the ancestral hominoid stock but there are certain types among the modern apes who have abandoned the arboreal way of life more or less completely. Orangutans and Chimpanzees can do without trees and Gorilla has become ground animal altogether. Correlated with the abandonment of tree life, is a tendency towards more or less two-legged walking and towards a more or less upright posture. Gorilla walks on soles of feet aided by knuckles of hands, with body inclined.

HOMINIDS

The characteristics described above in the case of monkeys and apes became very much more elaborated in the case of hominids -- the line leading to man. The anatomical features which distinguish man from apes are comparatively few, although they are important. Human brain is about double the size of an ape. This increase is mainly in the gray matter of the cerebrum. Here new centres have developed, such as centres of speech, and especially prominent are the areas where higher functions of the brain such as intellect, memory and judgement are located. The tooth row in man is shorter and rounded, and canine teeth are very much smaller. Thus face is less projecting and nose has become more prominent. Other important differences are associated with the change in locomotion habits. Man's arms are shorter than apes, and hand is more broad and flexible. Greater difference is in foot. In man the toes are short, the great toe has lost its primitive opposability and the calcaneum expands to form a prop at the back. Man's spine is much more sinuously curved than apes, with the effect of swinging the centre of gravity up above the hips and raising the head.

The above-said features are among those which distinguish modern human types from the Apes. Fossil human types tend to bridge the structural gap and exhibit intermediate conditions.

After branching away from the hominoid stock during the miocene, the hominid left the trees. Fore-limbs gradually came to be used mainly for gripping. With the increase in the complexity of hand-eye coordination, the brain enlarged further and intelligence increased enormously. The feet gradually evolved into flat walking platforms and along with the transformation to bipedal locomotion the gluteal muscles developed and buttocks became prominent, a unique feature of hominid. Thus the life on the ground promoted the evolution of platform feet and bipedal locomotion; gripping hands; more elaborate hand-eye coordination and enlargement of brain along with its highly complex functioning. As a matter of fact the modern man would not have evolved, if the ancestors had not adapted to arboreal life.

The Hominid Radiation. Hominid fossil finds are fewer as compared with other animals. For example, after working through tons of deposits one may find heaps of other finds such as marine creatures, before recovering a single human tooth. There are many reasons for it. Firstly the marine creatures were in great abundance when they lived and they continued to be abundant for a tremendous span of time. Their way of life helped to preserve them, as also did there shells, which are extremely durable. Men, by contrast, existed in small numbers, they appeared on the scene of life very late, they reproduced slowly and lived long. They were less liable to get mired in bogs, quicksands and tarpits. They lived and died out in the open where their bones could be eaten by scavengers, nibbled by ants, decomposed by the sun and rain, particularly in tropical countries where the soil is apt to be markedly acid. But when one realises how slight are the chances for the remains of prehistoric man to become fossilised and how short is the time, interest has centered in the problem, it appears that the record is not too poor. Yet it is not sufficient to establish a detailed pattern of the hominid radiation. Both prehistoric and modern man descended from common ancestors. They bear the relationship of cousin to cousin and not grand-parent to grand-child. Hominids probably evolved from different centres, each branch taking its course more or less independently of the others. All except our own line are now extinct. It is only possible to determine from a fossil when a certain hominid was alive but it is not yet possible to find out when he originated and when he became extinct. Besides anatomical findings, much has been learnt from the various signs of cultural activities accompanying the fossil finds, the type of shelter used, the type of food used and whether food gatherer or food producer (by animal domestication and agriculture), and the type of implements used. Until recently any hominid who made tools from natural objects, in addition to using them, was called a 'man'. But the definition of man as a maker of tools to a set and regular pattern had to be abandoned a few years ago, because Jane Goddall, who had been studying wild chimpanzees in their natural habitat, established that these distant cousins of man regularly make a simple variety of tools, although of perishable materials.

Some representative fossil human types are described herewith. Though they are few in number, yet they are enough to sketch out the key stages of man's march through time. Arranged in an ascending order some of them, those called 'pithecus', are apes, with increasing man-like characteristics; others are men with decreasing ape-like characteristics.

Proconsul. In 1951, Leakey (Fig. 101) in conjunction with Professor Le Gros Clark, published a mongraph, "*The Fossil Hominoidae of East Africa*". Amongst the specimens that they showed were numerous examples of a primate genus called Proconsul, a 25 million years old (Lower Miocene) fossil ape (Fig. 102). Three species were found varying from the size of a small chimpanzee to that of a gorilla. Procunsul possessed a number of characteristics that were more subjective of human than ape stock, although all others were that of an ape. He had a relatively short face, the lack of massive brow ridges, the rounded and humanoid morphology of mandibular condyle, the backward divergence of the rows of cheek teeth and the rectangular shape of the orbit. On the other side of the picture he had large ape-like canines, sectorial third premolars, a receding chin and upper incisors of ape morphology. Genus proconsul might perhaps represent the common ancestor of the great apes and man. Hence the name Proconsul; 'consul' means ape.

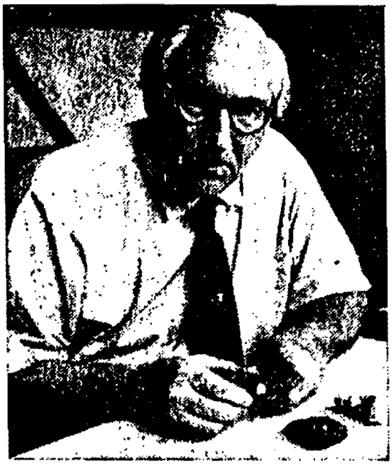


Fig.101.--LOUIS LEAKEY.

Oreopithecus. More definitely allied to or perhaps actually part of the hominid radiation is Oreopithecus, the mountain ape whose remains were found in Tuscany Northern Italy. The first finds in 1872 were claimed to be of a hominid. New discoveries in 1956 and 1968 have not modified this view. This primate dates back to some 10 million years to the early Pliocene. The teeth and jaw were distinctly hominid but in other respects the animal was still ape-like.

Fig. 102.—PROCONSUL.

Zinjanthropus. The East African man (Fig. 103). In 1959 Leakey discovered a fossil skull very similar to that of South African Australopithecus at Olduvai Gorge in Tanzania. It was named Zinjanthropus who lived 1,750,000 years ago in early Pleistocene. Numerous primitive stone tools were found in association with this fossil, as well as animal bones that had been broken open

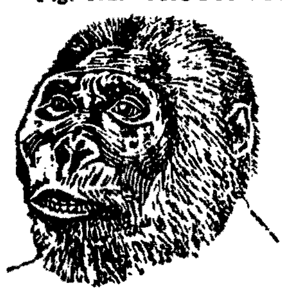
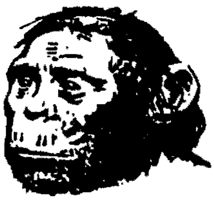


Fig. 103.—ZINJANTHROPUS.
(low forehead and small skull cavity)

to extract marrow and brains. According to the accepted definition of man at that stage, he being a tool maker was considered to be the first true man. His tools included wooden clubs and stone hammers. Large molar teeth show that his diet was mainly coarse vegetable. Bone structure of the skull reveals that the head was held very erect. Jaw muscles were attached as in modern man suggesting that he probably knew speech. On the other hand, a forehead was virtually absent. The brain volume could not be more than 600 cubic c.m., comparable to the brain of modern gorilla. Also a low bony ridge, was present on the top of the skull, another ape-like characteristic.

Homo-Habilis. The status of Zinjanthropus as first man was short lived as another even more ancient tool-making hominid was found in the same locality, three months later. This new species of genus Homo is called Homo-habilis existed and developed side by side for a period of approximately one million years. It is now suggested that man was evolved from *Homo-habilis* while numerous other branches developed away from the main stem and became over-specialised and eventually extinct.



Other known hominid fossils are of Pleistocene origin, i.e., not older than one million years. The oldest of these form a group of several genera of which Australopithecus is representative.

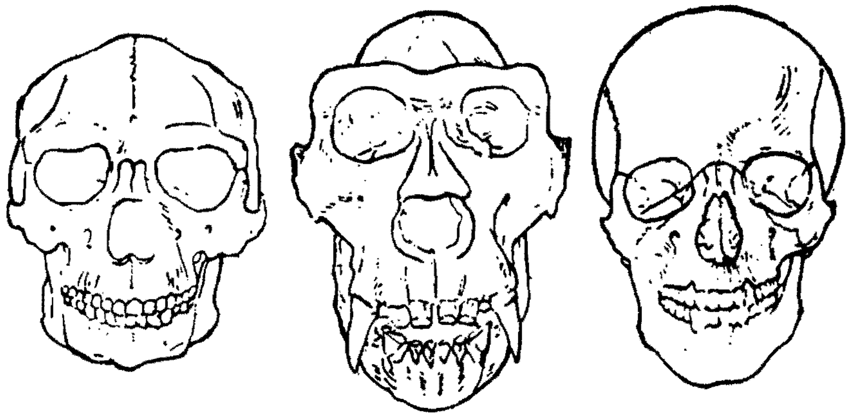
Australopithecus (Fig. 104). This is an extremely important group of fossils. Raymond Dart of Johannesberg announced the discovery of this fossil in 1926. Remains of this group have been found in South, Central and East Africa and date back to roughly I million years or less. Although they lived much later than Zinjanthropus, they were not as far advanced. They were tool users but perhaps not tool makers. Brain volume averaged 600 cubic c.m. They probably walked almost erect. Till 1946 Australopithecus was considered to be a fossil ape. In 1947, Professor Wilfrid and others came out strongly in support of its being a hominid rather than an ape.

Fig. 104.—AUSTRALOPITHECUS.

GENUS HOMO

Pithecanthropus (Pekin-man) (Fig. 105) is a much better known hominid. He made tools of stone and bone; and used fire for cooking, as evidenced by carbonised material and pieces of crudely chipped stones around. Remains of serveral species of Pithecanthropus were found in Java and China and were shown to be 500,000 years old. The brain volume averaged 900 to 1000 cubic c.m. The skull had a flat sloping forehead and thick eyebrow ridges and the massive protruding jaw without a chin. The teeth were somewhat primitive although essentially human. The femur fragments indicated medium stature and erect posture. (Fig.106) shows the skull of Pekin man as compared with gorilla and modern man.

Fig. 105.—PITHECANTHROPUS.



(*a*) (*b*) (*c*)

Fig. 106.--(*a*) SKULL OF PITHECANTHROPUS (PEKIN MAN) AS COMPARED WITH (*b*) GORILLA AND (*c*) MODERN MAN.

Eugene Dubois discovered the bits of a Pekin man fossil in Java in 1890. It was the oldest and most primitive human fossil known at that time. Davidson Black a Canadian professor of anatomy in a medical college in Pekin and his successor Franz Weidenreich later discovered a large number of fossils of this type in a large cave in the limestone hill about 30 miles away from Pekin. Recently in the Olduvai Gorge (East Africa) have been discovered a fossil skull, allied to Pekin-man skull, followed by the discovery of a smaller and less specialised example of the same skull type. Many regard this smaller type as the ancestral form of Pekin-man. Pekin-man is generally regarded as the same genus as man and is thus called *Homo Erectus*.

Homo Heidelbergensis (The Heidelberg man). Like Pithecanthropus he lived 500,000 years ears ago. He is known only from one fossil lower jaw found at Maner near Heidelberg, Germany in 1907. His status, therefore, cannot be fully assessed.

Homo Neanderthalensis (Fig. 107). He is the best known of all the different kinds of prehistoric people. The first fossil skull ever to be positively identified as belonging to ancient man was that of Neanderthaler and it was discovered in Neander valley, Germany in 1857. Average height about 64 inches, squat, shaggy, beetle-browed, very stocky and powerful. Probably walked with a shuffling slouching gait, as curved thigh bones and imperfect curvatures of the spine show that the limbs were habitually bent at hip and knee. Large head and heavy jaws were supported by powerful neck muscles. Probably arose some 150,000 years ago, flourished during the period of the last ice age and became extinct only 25,000

Fig. 107.—HOMO NEANDERTHALENSIS.

Fig. 108--NEANDERTHAL CAVEMEN

years ago. The brain had a volume of 1450 cubic c.m. about the size of a modern man. But the brain was proportioned differently. It was relatively simple as compared with modern man, especially in regions devoted to the higher mental activites. The skull protruded out in back where we are relatively rounded and forehead was low and receding, heavy ridges were still present. Jaw was massive and again virtually without chin. He was excellent hunter and tool maker. All Pleistocene hominids are generally regarded as belonging to the old Stone Age. But whereas earlier hominids made crude stone implements, neanderthal made a variety of weapons; tools, hunting axes and clubs and household equipment. Yet he was a caveman and a nomad (Fig. 108). He had neither agriculture, nor domesticated animals. He lived mostly in Europe but also along the African and Asian Coasts of Mediterranean. Recent skeleton was found in the cave of Robbers near Jeruslaem. As evidenced from the remarkable record of his life found on the cave walls in Combe Grenal, a huge site above the Dordogne valley in South-western France, he had pondered the nature of death and probably had felt the first primitive stirrings of religion.

Homo Sapiens. The time of orgin of our own species is not exactly known. The oldest representative of Homo Sapiens is *Swans-Combe Man*, known only through a few skull bones. These are from 500,000 to 250,000 years old. Early groups of modern man thus may have been contemporaries of Pekin-man.

Later groups include *Cromagnon Man* which were a splendid race physically (Fig. 109). He lived from 50,000 to 20,000 years ago and was a contemporary of other groups of Homo Sapiens living in different parts of world. He may have been the cause of extinction of neanderthal in Europe. He came to Europe from Middle East. Average Cromangnon man was 6 feet tall, but the women were very much smaller. Brain volume was 1500 cubic c.m. In addition to stone implements he used bone needles with which he may have sewn animal skins into crude garments. The remarkable Paleolithic art that still survives in certain Caverns of France and Spain attests his mental equipments. In addition to painting, Cromagnon man showed considerable proficiency as a sculptor and engraver. His treatement of his dead was careful and thoughtful. Dog was his companion but he still did not domesticate food animals and he did not practise agriculture. He was a cave-dwelling hunter. The racial division of modern man probably took place in his period (Fig. 110). The races, however, got mixed up later by inter-breeding. By the end of Pleistocene, some 20,000 years ago, all human species other than homo sapiens had become extinct. Ice began to retreat. Milder climates gradually supervened, and man no longer needed caves for shelter.

Fig. 109.—CROMAGNON MAN.

Next 15,000 years known as *Middle Stone Age* was characterised by great improvements in stone tools. Man was till a nomadic hunter.

New Stone Age. Began 5000 years B.C., the time Abraham (PBUH), the messenger of Allah settled in Canaan. That was a period of great cultural revolution. Man learnt to fashion pottery. He developed agriculture, and he was able to domesticate animals.

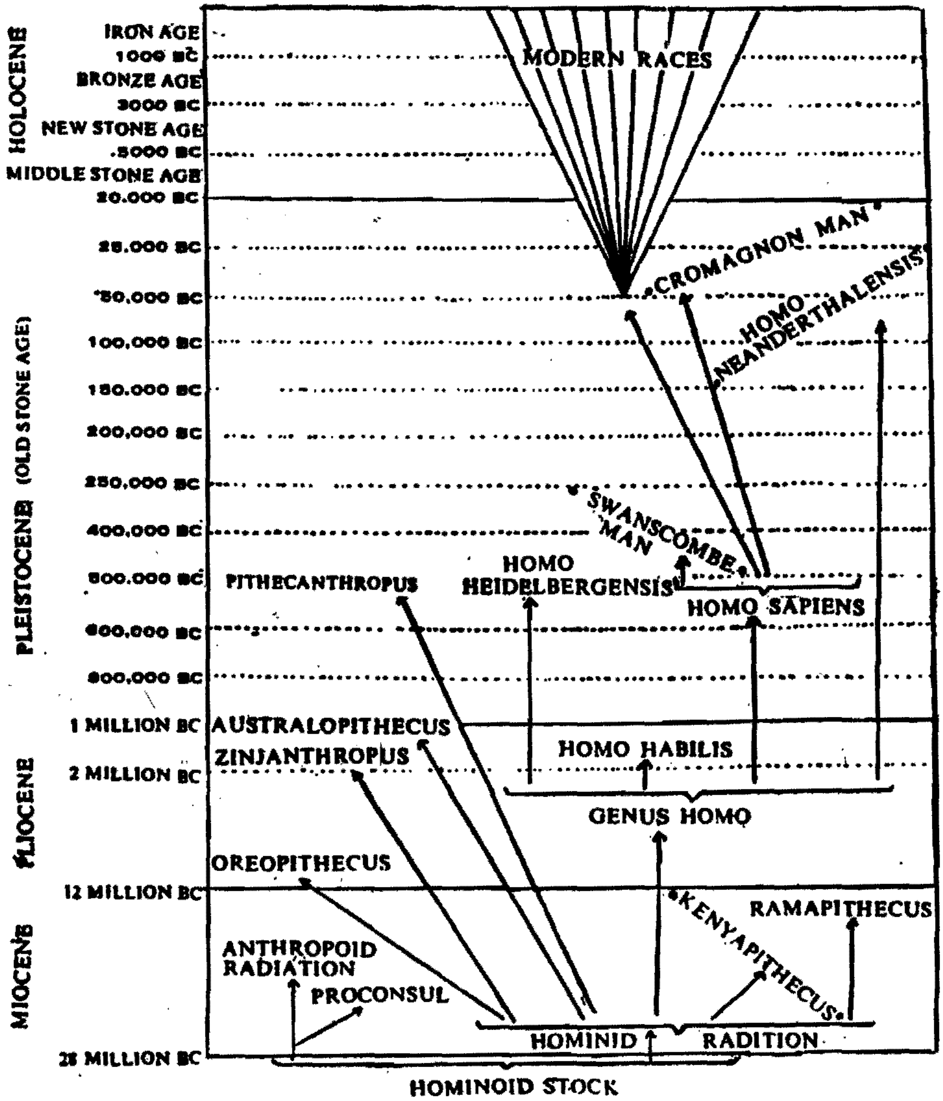


Fig.110.–HOMINDI RADIATION

Bronze Age. Started 3000 years B.C., and *Iron Age* started 1000 years before Christ. Not very long afterwards the modern man with his scientifc achievements appeared on the scene.

As noted in the beginning of Chapter XIV, the origin of man has been a topic of great interest for a long time. Primitive people had myths that implied human origin from animals or non-living materials by the creative acts of supernatural forces. But the structure and functions of the human body; its embryonic development; and historic, pre-historic and fossil; all indicate that modern man evolved through the operation of same forces which produced all other organisms. Man belongs to phylum Chordata, subphylum Vertebrata, class Mammalia, order Primate, superfamily Hominoid, family Hominid, genus Homo and species Homo Sapiens.

The characteristic features of his body are flatter and more vertical face, reduced eye-brow ridges, lower jaw less protruding, teeth more evenly sized. Hair long and of continuous growth on head but sparse and short on body. Hands more generalised, with opposable thumbs. Legs 30% longer than arms. Walks erect on platform feet. Buttocks well developed. Omnivorous in diet.

Man's brain is very much larger with far greater functional ability. He possesses an articulate speech and language. At some stage of evolution his embryonic development slowed down and his whole life cycle became prolonged. He is now perhaps the longest lived of all animals. The time to learn and gather experience has become very much longer. He has a highly developed cerebrum, with memory, judgement and intellect far too advanced. He has a unique functional ability to make tools which enabled him to exploit and finally dominate his environments. With tools he has hunted food, made clothings, built shelters and fashioned art. His range of emotions is great. He is the only animal that can appreciate beauty. He is far more aware of himself and far more individualised in personality than any other animal. He can reason out things, he can plan ahead. He has traditions and only he can accumulate knowledge through successive generations. The knowledge is transmitted from one generation to another, not through genes but through non-biological means, i.e., spoken and written speech. He is endowed with a 'self', he is able to choose between right and wrong, and possesses freedom of choice and will power.

Man is a social animal. Societies have already been described amongst insects and vertebrates other than man. Individuals in such societies possess certain characteristics by instinct, these are not the outcome of their social gatherings. On the other hand a single man as a member of his society possesses characteristics which are his because of his integration within a totality. For instance, such various forms of expression in his generic individuality as language, religion, law, customs, etc., can never be rooted in an isolated individual. A person thinks, speaks a certain language and acts in a characteristic way, because of his participation in an integrated whole.

Man has thus entered a new phase of evolution. The first change, over 2000 million years ago, superadded biological to chemical evolution and laid open a vast field of opportunities for matter to rearrange itself, in so many different ways. On the other hand the present change-over has superadded human to biological evolution and has created new possibilities. Since man appeared on the scene, he has begun to manipulate and modify the chance operations of nature. But the future of man does not depend alone on his capacity to control and modify environments to his own advantage, but also on his ability to use his freedom of choice in the right direction, and on the purpose for which he utilises his achievements. This is going to be the directive force for the future course of his evolution.

MAN A DISTINGUISHED CREATION (خلق آخر)

The Holy Quran relates the story of evolution, beginning from inorganic matter up to man, in so many different ways and describes man as a distinguished creation.

Let us recollect verses (23:12-14) described earlier--"We created man from the extracts of inorganic elements of clay. Then We placed him as a sperm drop in its temporary abode, to be firmly fixed. From this fluid We created 'a hanging mass'. Then We created from 'the hanging mass' an embryo. Then We created the bony framework inside the embryo. Then We covered the bony framework with muscles." After the above description it is said:

ثُمَّ اَنْشَاْنٰهُ خَلْقًا اٰخَرَ

"Then We brought him forward as entirely a new and distinguished creation."

Let us see what are the points of distinction:-

Ruh. The first distinguishing feature is the possession of 'Ruh' or 'Divine energy':

اَلَّذِيْٓ اَحْسَنَ كُلَّ شَيْءٍ خَلَقَهٗ وَبَدَاَ خَلْقَ الْاِنْسَانِ مِنْ طِيْنٍ ۚ ثُمَّ
جَعَلَ نَسْلَهٗ مِنْ سُلٰلَةٍ مِّنْ مَّآءٍ مَّهِيْنٍ ۚ ثُمَّ سَوّٰىهُ وَنَفَخَ فِيْهِ مِنْ
رُّوْحِهٖ وَجَعَلَ لَكُمُ السَّمْعَ وَالْاَبْصَارَ وَالْاَفْـِٕدَةَ ۗ قَلِيْلًا مَّا تَشْكُرُوْنَ
(32:7-9)

"It is He Who has made, all that is created, in due proportion. And He initiated the creation of man from the inorganic matter of the earth and made his progeny from an extract of the nature of a despicable fluid. Then He fashioned him in due proportion and breathed into him His Ruh and gave you the faculties of Hearing, Sight and Mind. But very few of you make the right use of these faculties."

To find out the nature of 'Divine energy' and how it works actually, is not within the domain of perceptual knowledge.

وَيَسْـَٔلُونَكَ عَنِ الرُّوحِ ۖ قُلِ الرُّوحُ مِنْ أَمْرِ رَبِّي وَمَا
أُوتِيتُم مِّنَ الْعِلْمِ إِلَّا قَلِيلًا ○ (17:85)

"And they ask thee (O Muhammad) concerning the 'Divine energy'. Say: The Divine energy comes from the command of thy Sustainer. Of its knowledge it is only a little that is communicated to you."

However, the divine energy, according to the Holy Quran, manifests itself in various ways in the universe. In human individuals it appears in a specific form which is known as *Nafs* in the Quranic terminology. All human actions, dependent on freedom of choice and will, cast their image on *'Nafs'* or *'Human Personality'*. The Nafs presents itself in man in an undeveloped form and has got immense potentialities. It has got the capacity to develop on the blueprints of divine attributes. The potentialities become actualised by such human actions which are in conformity with the Divine laws given to mankind through the messengers of Allah. He who gradually develops the *nafs*, draws closer to Allah, i.e., he realises and manifests Divine attributes within himself. The more the human self is developed. the more it is capable of survival and fit for passing on to its higher stage of evolution after physical death. On the other hand one whose actions are in the opposite direction, causes to produce the disintegration of *Nafs*, i.e., he recedes from the real and draws closer to the unreal.

The Holy Quran says:

وَنَفْسٍ وَمَا سَوَّاهَا ○ فَأَلْهَمَهَا فُجُورَهَا وَتَقْوَاهَا ○ قَدْ
أَفْلَحَ مَن زَكَّاهَا ○ وَقَدْ خَابَ مَن دَسَّاهَا ○ (91:7-10)

"By the *Nafs* and its perfection. He endowed it with the posssibilities of both integration and disintegration. Truly he succeeds who nourishes it and he fails who stunteth it"

Thus human *Nafs* is progressive and to undergo evolution is in its nature. The Holy Quran explains the human actions and their recording on *Nafs* by calling it طائر or a bird. You keep control over a bird as long as it is in your grip. Once the grip is loosened, it is out of your control. Every cause has got its effect and every human action, however slight, must leave its imprint on the screen of *Nafs*. It is not in one's control to check it. Man is thus composed of two distinct entities, physical body and *Nafs* and both lie in close proximity to each other:

وَكُلَّ إِنسَانٍ أَلْزَمْنَاهُ طَائِرَهُ فِي عُنُقِهِ ۖ وَنُخْرِجُ لَهُ يَوْمَ الْقِيَامَةِ كِتَابًا يَلْقَاهُ
مَنشُورًا ○ اقْرَأْ كِتَابَكَ كَفَىٰ بِنَفْسِكَ الْيَوْمَ عَلَيْكَ حَسِيبًا ○ (17:13-14)

"Every man's 'bird' We have pasted to his own neck and We shall bring forth for him on the day of Judgement a book which he shall find wide open. (It will be said to him:) Read your own record. Your *Nafs* is sufficient this day to make an account of yourself."

As stated above, the making and breaking up processes of *Nafs* or human personality are affected only by those actions which are performed wilfully and after making a choice. It is the '*Ruh*' or 'Divine energy' which confers on man the capacity to choose between right and wrong and thus provides man the unique distinction to act freely as he chooses. The freedom of Choice and Will., thus, become the directive force in human evolution which in fact is the evolution of '*Nafs*' or 'Human personality'.

Speech. The other feature that distinguishes man from lower animals is the faculty of speech. The Holy Quran says:

(55:3-4) خَلَقَ الْإِنْسَانَ ۙ عَلَّمَهُ الْبَيَانَ ۝

"He created man. He taught him speech".

(The following description of 'Speech' is based mainly on "*Introduction to Clinical Neurology*" by Gordon Holmes.):-

The term speech signifies the expression of thoughts by auditory and visual means for their conveyance to others and the comprehension of the ideas of others, by means of their written and spoken words.

The use of spoken and written words to express our thoughts and receive the thoughts of others is known as external speech but it depends on internal speech, that is the formulation in our minds of unlettered words. It includes in addition to the mental processes that are expressed in external speech, those concerned in the understanding of the speech of others. Our thoughts deal prominently in terms of speech; words and verbal symbols can be regarded as the coins of mental commerce. It is for instance a common experience that during preoccupation not only do we formulate our ideas in words but may even form or utter words subconsciously.

Speech is consequently a product of mind, a psychological as well as a physiological function, by which mind can be exteriorised for the purpose of communication with our fellows; but it is also an instrument of mind, for without speech our mental activites are restricted. A speechless man is not, however, necessarily thoughtless.

As stated earlier in this chapter, animals are also able to express themselves. The birds utter calls and songs to assemble gregarious species, to advertise nesting territory and attract mates, to give directions to their young and to warn in the event of danger. Similarly in other animals the calls carry different meanings, one call becomes a symbol of hurt, another a symbol of hunger or desire for food. In apes the use of such symbols to express emotions, desires and even rudimentary thoughts is undoubtedly more highly developed, but in man only has the use of symbols in thinking and in expression of thoughts reached that stage where it can be referred to as speech.

Development of speech in man. The hominids probably first employed sounds as a vehicle for the expression of thought, like their ancestors to whom the utterance of a simple sound signified little more than an emotion, but they gradually learned to employ other sounds, at first perhaps applied to concrete objects only, and to recognise their significance when they were uttered by their fellows. Thus a simple sound like "ma" may have signified mother and some other elementary sound corresponded to food or desire for nourishment. In this way words for auditory symbols came into use. These sounds which became words were, however, and have remained conventional symbols but each one of them has been invested with an arbitrary, though definite connotation. As greater power of articulation was acquired they became more numerous and more differentiated. The vocabulary grew gradually, providing more names for concrete objects and for abstract qualilties possessed by them. Later there was acquired the use of other sound-symbols, or words to connect or relate those first acquired to one another, to one's self or to some other object; and modification of words served to indicate number, time and conceptual relations. In this way sentences were acquired; this extended enormously the utilitly of speech.

This is the course of development in individual life too. The significance of names or sounds applied to objects, is first apprehended; then the child learns, after many attempts, to utter and apply the same sounds to these objects. Later, he succeeds in combining words into sentences, and becomes able by the use of verbs to say something about persons and things, by adjectives to qualify or add to the meaning of the words he uses, and to indicate relations between them by other elements of speech.

The auditory impressions early impressed and expressed remain throughout life the most stable, least vulnerable and the longest lasting of the methods of receiving and communicating ideas. Whereas we entirely rely on visual memories for our remembrance and intelligence in general matters, yet as regards speech we rely upon auditory memories to a very large extent, and of course those who have never learned to read, do so exclusively. The process of recall, both in silent thought and in speaking, is the revival of auditory patterns.

Speech is consequently the use of symbols, to express thoughts, and as stated above at first auditory symbols, or spoken words, only were employed. These word symbols are, however, conventional; they vary in different languages, but in each language they become fixed and standardised. The first essential step in the development of language is appreciation of the significance of these conventional symbols. If their significance is not learned, as in congenital deafness, speech is not acquired naturally, and when speech is lost they can no longer serve as a vehicle for thought and its expression; words become only a medley of sounds like those of an unknown foreign language.

Written speech. Unlike insects and vertebrate societies, described in Chapter VIII, which are guided by instinct, the human society, based on freedom of choice and will, had much complex functions to perform. The human evolution thus required a much closer and broader link among men inhabiting different parts of the globe at one time and men living in different periods of time. Such a link became possible through the permanent records of speech, because the spoken words when uttered are gone for ever, like the breath which carries them. It is at this stage of human evolution that the Holy Quran said:

(96:4-5) الَّذِي عَلَّمَ بِالْقَلَمِ ۝ عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ ۝

"He Who taught (the use of) pen. Taught man what he knew not."

As the Divine message was to spread far and wide, through time and space, and the message was not carried to individual human beings, written speech formed the nucleus for the spread of human knowledge.

In primitive men, human thoughts were first recorded in drawings and pictures. The pictorial system of writing was prevalent amongst the ancient Egyptians. Such figures representing a word or sound or syllable are known as hieroglyphs (Fig. 111). A hieroglyph may be (A) a pictograph, standing for the object itself, or (B) an ideograph, standing for an idea associated with the object, or a (C) phonogram, standing for a sound or syllable or whole word, or (D) determinative. For example D1 in this figure represents heaven, D2 represents heaven and star or night, D3 a divine person, D4 prayer, worship or praise. Original Chinese scripts also represented things without words or names. But the hieroglyphs remained merely pictorial representations of objects, not records of their conventional names.

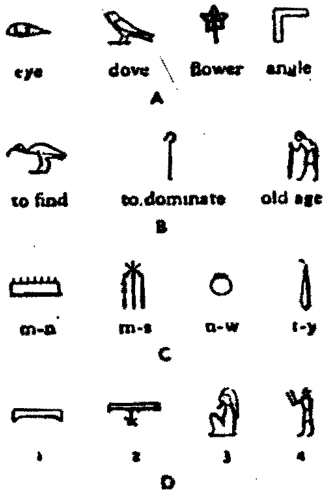


Fig. 111.—HIEROGLYPHS.

A—Pictographs. B—Ideographs.
C—Phonograms. D—Determinatives.

Writing on the other hand is the recording of auditory symbols by graphic symbols. A separate symbol might be selected for each word and modification of a word, but this would be a cumbersome and inflexible method. The first stage in the development of writing, as we understand it, was the breaking up or analysis of the complex sounds of words into a number of simple elements, which when rearranged and combined are capable of representing all the sound symbols or words of the language. These elements are the letters of the alphabet. The next stage was to adopt conventional visual symbols for the letters which when properly arranged would represent words. In writing and reading, therefore, we employ symbols of symbols, for writing is built up of visual symbols of auditory symbols. Writing and reading are consequently largely dependent on auditory speech. They are also more artificial faculties than articulate speech; they are learned by each individual later in life, and may not be acquired in the absence of education; in fact, many races, some of which possess highly developed languages, as the Cree Indians of North America, have never learnt to record their words by visual symbols.

It is however, propositions or a series of words in which something is stated, affirmed or denied, not words themselves, which are the units of speech. Single words are meaningless unless related to other words; even 'Yes' has a meaning only when it signifies "I will do it", or "I have done it," or " I agree with what you say," or any other affirmation.

Speech, consequently, consists in the formlulation of propositions in mind, their expression by written or spoken words, and the comprehension of such propositions when presented by others by sounds or in writing.

The formulation of propositions is a psychological function, and the comprehension of speech when heard or read in print is psychological too, but as all psychological functions, they must have a physiological basis. The expression of propositions in spoken words or in writing is, however, a physiological process; the organisation, grading and the coordination, as well as the execution, of the movements of the larynx, palate, tongue and lips and of those of the fingers which guide the pen, are dependent on the integrity of localised anatomical structures.

It is therefore obvious that speech is essentially a mental process by which formulae or patterns, in which our ideas can be communicated to others by means of auditory (words) or visual (writing) symbols, are determined, and by which we are enabled to understand the significance or import of such symbols when made use of by others (*Gordon Holmes*).

The role of motor functions in speech -- It is essential to bear in mind, that all motor processes have been evolved from reflex actions, and that all living motion is sensory-originated, sense-guided and sense-governed; and that a motor process of itself has no proven conscious concomitant; our consciousness of motor processes being the consciousness of the sensations which accompany the movement or which result from the movement. Thus in speaking we gain the knowledge that we have spoken, what we wished, correctly by the immediate backward lash of our voices, sounding in our ears, and also by the sensation of correct articulation which reaches the sensorium from the executive organs. The knowledge of correct execution so gained fortifies and increases the functional stability of the speech area of the brain and is of immense importance in speech function (*James Collier*).

We may infer from the above description that when the Holy Quran says عَلَّمَهُ الْبَيَانَ it refers to the evolutionary stages through which the Internal and External speech gradually developed, as a distinguishing feature of man.

THE STAGES OF HUMAN LIFE

According to the verse given below and which has already been quoted in the last chapter, the life initially made its appearance in the inorganic matter of the earth. Then it gradually evolved, and passed through the stage of sexual reproduction to the stage of internal fertilisation and intra-uterine growth. After birth man passes through stages of childhood, full strength and decline. At old age comes degeneration, an irreversible process known as Biomorphosis, the rate of which is characteristic of the species and also differs to a certain extent in different individuals. At the end of this process comes death:

هُوَ الَّذِي خَلَقَكُم مِّن تُرَابٍ ثُمَّ مِن نُّطْفَةٍ ثُمَّ مِنْ عَلَقَةٍ ثُمَّ يُخْرِجُكُمْ طِفْلًا
ثُمَّ لِتَبْلُغُوا أَشُدَّكُمْ ثُمَّ لِتَكُونُوا شُيُوخًا وَمِنكُم مَّن يُتَوَفَّىٰ مِن قَبْلُ وَ
وَلِتَبْلُغُوا أَجَلًا مُّسَمًّى وَلَعَلَّكُمْ تَعْقِلُونَ
(40:67)

> "It is He Who created you from dust, then from a sperm drop, then from an "Alaqa". Then He brings you forth as a child, then He lets you reach the age of full strength, then He lets you become old. Then some among you die earlier and others reach an appointed term, perhaps you may under-stand."

Life After Death. But according to the Holy Quran, the human personality does not end with the physical death, it is only the physical body that ends. The making and breaking up processes go on side by side in the human body as well as in the human personality. The human body gets nourishment from various kinds of foods and the waste products get eliminated in the form of carbon dioxide, urine, faeces and perspiration. The process continues throughout life. After physical death the entire human body undergoes decay and disintegration. The human personality, on the other hand, is nourished by those human actions which are in conformity with the Divine laws, given to mankind through the messengers of Allah; and disintegrates by those actions which are repugnant to the Divine laws. The human personality is not affected by the physical death. If its potentialities are actualised, it is fit to survive and pass on to the evolutionary stages that lie ahead.

The non-believers do not agree with the presence of a 'human personality'. It has been scientifically established that the atoms of a human body are continuously being replaced by new ones and the entire human body gets changed after a few years. According to the recent findings every single atom of a human femur, the largest bone of the human body, gets replaced after six months or so. The question arises, as to how the contracts between two individuals persist, after a period of , say, ten or fiteen years, as for instance the marraige contract between a husband and a wife; because physically these two individuals are not the same as a decade earlier. Even a person is not entitled to his bank balance after the lapse of a few years because physically the depositor no more exists. In this respect the Holy Quran says:

ءَإِذَا مِتْنَا وَكُنَّا تُرَابًا ۖ ذَٰلِكَ رَجْعٌ بَعِيدٌ ۝ قَدْ عَلِمْنَا مَا تَنْقُصُ
الْأَرْضُ مِنْهُمْ ۖ وَعِنْدَنَا كِتَٰبٌ حَفِيظٌ ۝

(50:3-4)

> "(Those who lack true knowledge) say 'when we die and become dust, (shall we come to life again?). That return is far from comprehension'. Allah says, 'We know what the earth takes away from them (the human beings)'. (Their personality remains, and human actions are intimately connected with human personality) so its safe record is kept with Us."

The above applied to human individuals. According to holy Quran the life of human species is also a life of probation:

هُوَ الَّذِي خَلَقَكُمْ مِّنْ طِينٍ ثُمَّ قَضَىٰ أَجَلًا ۖ...

(6:2)

> "He it is Who created you (human species) from clay, and then decreed a stated term (for you)."

THE HOLY QURAN ON SIX ERAS OF EVOLUTION

As stated earlier in this chapter, the Holy Quran divides the evolutionary period before life began on the Earth into two eras (يومين), and the period after the appearance of life into four eras(اربعة ايام). Thus the entire period since the beginning of the universe is divided into six eras and these have been beautifully described in the Quran in various contexts.

We also noted that according to the Holy Quran, there is a period of Divine Planning before a creation appears in its manifest form and that the planning is a part of the creation itself. The Holy Quran explains it further:

إِنَّ رَبَّكُمُ اللَّهُ الَّذِي خَلَقَ السَّمَٰوَٰتِ وَالْأَرْضَ فِي سِتَّةِ أَيَّامٍ
ثُمَّ اسْتَوَىٰ عَلَى الْعَرْشِ يُدَبِّرُ الْأَمْرَ ۖ...

(10:3)

> "Verily your 'رب' is Allah Who created the heavenly bodies and the earth in Six Eras. And He established Himself on the throne of authority, planning His Schemes."

At yet another place, the Holy Quran describes the creation of the universe in Six Eras, in support of the truth of the laws given to mankind through revelation; and impresses upon the human beings that just as the process of creation of the universe progresses smoothly in compliance with the Divine laws, so shall the humanity reach the goal set for her, by following the laws given to her through revelation. No law other than the one given by the Creator and no outside help can achieve the objective. This is because the whole process of creation is according to plan and when a plan is intended to be executed, its starting point is made at the lowest level and then it is raised up step by step to its highest level; and the whole scheme is executed all along within a specified pattern:

اَللّٰهُ الَّذِیْ خَلَقَ السَّمٰوٰتِ وَالْاَرْضَ وَمَا بَیْنَهُمَا فِیْ سِتَّةِ اَیَّامٍ ثُمَّ اسْتَوٰی
عَلَی الْعَرْشِ مَا لَكُمْ مِّنْ دُوْنِهٖ مِنْ وَّلِیٍّ وَّلَا شَفِیْعٍ اَفَلَا تَتَذَكَّرُوْنَ ۝ یُدَبِّرُ
الْاَمْرَ مِنَ السَّمَآءِ اِلَی الْاَرْضِ ثُمَّ یَعْرُجُ اِلَیْهِ فِیْ یَوْمٍ كَانَ مِقْدَارُهٗ
اَلْفَ سَنَةٍ مِّمَّا تَعُدُّوْنَ ۝ ذٰلِكَ عٰلِمُ
الْغَیْبِ وَالشَّهَادَةِ الْعَزِیْزُ الرَّحِیْمُ ۝

(32:4-6)

> "It is Allah Who created the heavenly bodies and the earth and all between them in Six Eras and is firmly established on the throne of authority. Nothing except His law can protect you and no intercession can be of any help to you. Then, will you not obey His law? There are Divine plans. When a plan is intended to be executed its starting point is made at the lowest level. Then it is raised up step by step to its highest level. It rises up from one stage to another in a certain period which may be a thousand years of your reckoning. Such is the One Whose knowledge covers all that is beyond your conception and all that is manifest before you. He is exalted in power and He provides nourishment within a specifed pattern."

The Holy Quran relates yet another important point, that before these six eras of evolution started, there was nothing in this universe except Allah Himself; and that life and death are controlled by His law which prevails all over the universe:

سَبَّحَ لِلّٰهِ مَا فِي السَّمٰوٰتِ وَالْاَرْضِ وَهُوَ الْعَزِيْزُ الْحَكِيْمُ ۝ لَهٗ مُلْكُ السَّمٰوٰتِ وَ
الْاَرْضِ يُحْيٖ وَيُمِيْتُ وَهُوَ عَلٰى كُلِّ شَيْءٍ قَدِيْرٌ ۝ هُوَ الْاَوَّلُ وَالْاٰخِرُ وَالظَّاهِرُ
وَالْبَاطِنُ وَهُوَ بِكُلِّ شَيْءٍ عَلِيْمٌ ۝ هُوَ الَّذِيْ خَلَقَ السَّمٰوٰتِ وَالْاَرْضَ فِيْ سِتَّةِ
اَيَّامٍ ثُمَّ اسْتَوٰى عَلَى الْعَرْشِ يَعْلَمُ مَا يَلِجُ فِي الْاَرْضِ وَمَا يَخْرُجُ مِنْهَا وَمَا يَنْزِلُ
مِنَ السَّمَآءِ وَمَا يَعْرُجُ فِيْهَا وَهُوَ مَعَكُمْ اَيْنَ مَا كُنْتُمْ وَاللّٰهُ بِمَا تَعْمَلُوْنَ بَصِيْرٌ ۝
لَهٗ مُلْكُ السَّمٰوٰتِ وَالْاَرْضِ وَاِلَى اللّٰهِ تُرْجَعُ الْاُمُوْرُ ۝ (57:1-5)

'All that exists in this universe fervently follows the Divine programme. He is exalted in might and full of wisdom. His law prevails in the universe. Life and death are controlled by His law. He has set standards over which He has perfect control. He is the First and the Last (He has no beginning and no end. He is above and beyond the realm of time and space). The working of His law is imperceptible but the resultant creation is manifest. He has complete knowledge of all things. It is He Who created the heavenly bodies and the Earth in Six Eras and is firmly established on the throne of authority. He knows what enters the earth and what comes out of it, what comes down from heaven and what mounts up to it. And He is with you wherever you may be. All that you do is within His sight. He is the Sovereign power over the heavens and the earth and all affairs are settled by His laws."

The history of evolution reveals that life is intimately connected with water. Where-ever there is life, there is water; and where-ever there is water, the life there exists, either in actual or in potential form. It is now believed by the scientists that water has played a tremendous role in forming the terrene of planets, as well as of the earth; that even today the interior of a number of planets, including those close to the Earth, contains water which exerts a certain influence on their relief and there is likelihood of primary forms of life appearing there. Thus where-ever there is water, we presume that it is a preparation for the appearance of life, though it may appear millions of years later. We have seen in the verse (57.2) above that life and death are controlled by the Divine laws. One of these laws is that water appears as a preliminary to the appearance of life.

The Holy Quran says:

وَهُوَ الَّذِيْ خَلَقَ السَّمٰوٰتِ وَالْاَرْضَ فِيْ سِتَّةِ اَيَّامٍ وَّكَانَ عَرْشُهٗ عَلَى الْمَآءِ ... (11:7)

"It is He Who created the heavenly bodies and the earth in Six Eras.; He made water the basis of life, over which He kept His control."

Ignorance is the basis of unbelief in Allah. The more the human knowledge increases about the phenomena of nature and the laws operating them, the more we get convinced that the controlling authority of the universe is One and that the process of creation takes shape within a specified pattern:

الَّذِي خَلَقَ السَّمٰوٰتِ وَالْأَرْضَ وَمَا بَيْنَهُمَا فِي سِتَّةِ
أَيَّامٍ ثُمَّ اسْتَوٰى عَلَى الْعَرْشِ ۚ الرَّحْمٰنُ فَسْئَلْ بِهِ خَبِيرًا ۝

(25:59)

> "It is He Who created the heavenly bodies and the Earth and (all) that is in between, in Six Eras and is firmly established on the throne of authority. It is He Who provides nourishment within a specified pattern. So you ask about Him, from one who is acquainted."

The phenomena of nature are so attractive, methodical, constructive and instructive, yet a great majority of human beings are unmindful of them. The Holy Quran says:

وَكَأَيِّنْ مِّنْ اٰيَةٍ فِي السَّمٰوٰتِ وَالْأَرْضِ يَمُرُّوْنَ
عَلَيْهَا وَهُمْ عَنْهَا مُعْرِضُوْنَ ۝

(12:105)

> "And how many clear signs in the heavens and the earth do they pass by! Yet they turn away (their faces) from them."

THE CREATION BY ALLAH IS CONSTRUCTIVE

The more we explore nature, the more we find the coordiation in the functioning of the component parts of the universe. It indicates that the Divine plan is constructive and that there is a purpose behind the creation of the universe. The Holy Quran points out this fact at various places:

هُوَ الَّذِي جَعَلَ الشَّمْسَ ضِيَاءً وَّالْقَمَرَ نُوْرًا وَّقَدَّرَهٗ مَنَازِلَ
لِتَعْلَمُوْا عَدَدَ السِّنِيْنَ وَالْحِسَابَ ۚ مَا خَلَقَ اللّٰهُ ذٰلِكَ إِلَّا
بِالْحَقِّ ۚ يُفَصِّلُ الْاٰيٰتِ لِقَوْمٍ يَّعْلَمُوْنَ ۝

(10:5)

> "It is He Who made the sun, the source of light and the moon a reflected light and measured out stages for her that you may know the number of years and the count (of time). This is nothing but a part of His constructive design. He explains His signs in detail, to those who understand."

أَوَلَمْ يَتَفَكَّرُوا فِي أَنفُسِهِم ۗ مَّا خَلَقَ اللَّهُ السَّمٰوٰتِ وَالْأَرْضَ وَمَا بَيْنَهُمَا
إِلَّا بِالْحَقِّ وَأَجَلٍ مُّسَمًّى ۗ وَإِنَّ كَثِيرًا مِّنَ النَّاسِ بِلِقَاءِ رَبِّهِمْ لَكَافِرُونَ ○

(30:8)

"Do they not contemplate in their own minds that Allah has created, the heavenly bodies and the earth and all between them, for a just and constructive purpose and for an appointed term and yet there are many a people who deny facing the Divine law (in their own sphere of life)."

وَهُوَ الَّذِي خَلَقَ السَّمٰوٰتِ وَالْأَرْضَ بِالْحَقِّ ۖ ... (6:73)

"It is He Who created the heavenly bodies and the Earth, concrete, constructive and purposeful."

خَلَقَ السَّمٰوٰتِ وَالْأَرْضَ بِالْحَقِّ ۚ تَعَالَىٰ عَمَّا يُشْرِكُونَ ○ (16:3)

"He has created the heavens and the Earth, constructive and full of purpose. He is exalted above all that they associate with Him!"

خَلَقَ اللَّهُ السَّمٰوٰتِ وَالْأَرْضَ بِالْحَقِّ ۚ إِنَّ فِي ذَٰلِكَ لَآيَةً لِّلْمُؤْمِنِينَ ○ (29:44)

"Allah created the heavens and the Earth concrete, constructive and purposeful. Verily in that is a clear sign for those who believe."

وَلِلَّهِ مُلْكُ السَّمٰوٰتِ وَالْأَرْضِ ۗ وَاللَّهُ عَلَىٰ كُلِّ شَيْءٍ قَدِيرٌ ○ إِنَّ فِي خَلْقِ
السَّمٰوٰتِ وَالْأَرْضِ وَاخْتِلَافِ اللَّيْلِ وَالنَّهَارِ لَآيَاتٍ لِّأُولِي الْأَلْبَابِ ○ الَّذِينَ
يَذْكُرُونَ اللَّهَ قِيَامًا وَقُعُودًا وَعَلَىٰ جُنُوبِهِمْ وَيَتَفَكَّرُونَ فِي خَلْقِ السَّمٰوٰتِ
وَالْأَرْضِ رَبَّنَا مَا خَلَقْتَ هَٰذَا بَاطِلًا سُبْحَانَكَ فَقِنَا عَذَابَ النَّارِ ○ (3:188-190)

"To Allalh belongs the sovereignty of the heavens and the Earth and He has specific standards for every thing. Behold! in the creation of the heavens and the Earth and the alternation of day and night, there are indeed signs for men who think over it : men who keep before themselves the Divine law, standing, sitting, and lying down on their sides and contemplate (wonders of) creation in the heavens and the Earth (with the thought): Our Rabb, Thou hast not created all this without a purpose. Praise be to Thou. Give us knowledge to discover the laws of nature to save ourselves from destruction."

وَمَا خَلَقْنَا السَّمٰوٰتِ وَالْاَرْضَ وَمَا بَيْنَهُمَا لٰعِبِيْنَ ۝ مَا
خَلَقْنٰهُمَآ اِلَّا بِالْحَقِّ وَلٰكِنَّ اَكْثَرَهُمْ لَا يَعْلَمُوْنَ ۝

(44:38-39)

"We did not create the heavens and the Earth and all between them useless or without purpose. We did not create them except for a reality that cannot be challenged but most of them do not know it."

The Purpose. The question arises, what is the purpose of all that has been created? As far as we can understand from the words of the Holy Quran the present is only a preparation of a future stage of evolution. What is the exact nature of the next stage is beyond our perception. The spectacular animals of the mesozoic era could never perceive the shape of the modern world. So it is not even possible for a human fetus to know what he is going to be after birth. But one thing is certain. The next higher stage for the human beings is not going to evolve on the basis of physical characteristics but on the basis of development of human personalilty, at its present stage. According to the Holy Quran at the termination of the six Eras of evolution already described, the process of creation still continues and it is now to be seen which one of you is capable of survival for the next stage on the basis of a balanced personality, developed through constructive efforts.

وَهُوَ الَّذِىْ خَلَقَ السَّمٰوٰتِ وَالْاَرْضَ فِىْ سِتَّةِ اَيَّامٍ وَّكَانَ
عَرْشُهٗ عَلَى الْمَآءِ لِيَبْلُوَكُمْ اَيُّكُمْ اَحْسَنُ عَمَلًا ...

(11:7)

"It is He Who created the heavenly bodies and the Earth in Six Eras. He made water the basis of life, over which He kept His control. (This lengthy process of evolution was carried out) so that He might provide you the opportunity and see which one of you has made the balanced efforts (and has thus proved himself capable of survival for the next stage.)"

Again it is said:

الَّذِىْ خَلَقَ الْمَوْتَ وَالْحَيٰوةَ لِيَبْلُوَكُمْ اَيُّكُمْ اَحْسَنُ عَمَلًا ...

(67:2)

"He Who created death and life, that He may try whose deeds are proportionate and balanced."

Life is the result of positive and constructive, in other words, of balanced, united and integrated acts: and death is the result of negative and destructive, in other words, of unbalanced, disunited and disintegrated acts. This applies to all forms of life, including human, at every evolutionary stage. The balanced acts mean survival and the unbalanced acts mean extinction. The present stage of human life is a testing ground where unfit are sorted out from the fit, i.e., those who are capable of passing on to the higher scale of evolution.

Another important aspect that the Holy Quran points out, is the accuracy of the evaluation of human acts. All affairs in the universe are controlled by One Sovereign Authority. The human species being the latest and the distinguished creation, is the end product of the past evolution. Thus the entire performance in the universe is meant to produce accurate results of human activities, so that not a single act, however insignificant it may appear, may remain unaccounted and unrewarded.

Thus it is said:

وَخَلَقَ اللّٰهُ السَّمٰوٰتِ وَالْاَرْضَ بِالْحَقِّ وَلِتُجْزٰى
كُلُّ نَفْسٍ بِمَا كَسَبَتْ وَهُمْ لَا يُظْلَمُوْنَ ٥

(45:22)

> "Allah created the heavens and the earth for constructive purposes, so that every act of every human being may produce an accurate result and that none of them be wronged."

CHAPTER XVI

Man and the Phenomena of Nature

وَسَخَّرَ لَكُمْ مَّا فِي السَّمٰوٰتِ وَمَا فِي الْأَرْضِ جَمِيْعًا مِّنْهُ ۚ
إِنَّ فِيْ ذٰلِكَ لَاٰيٰتٍ لِّقَوْمٍ يَّتَفَكَّرُوْنَ ۝

(45:13)

"And He has made subjected to you (O mankind!) all that is in the heavens and all that is in the earth : behold, herein verily are signs for those who reflect."

One of the factors, that control the rise and fall of nations in particular, and the psychological growth as well as retardation of individuals in general, is the way they think about and react to the forces of nature,. Man in his primitive stage was afraid of these forces. He considered any thing mightier than himself a deity and bowed down before it. He bowed down before the sun, the stars, the lightning, the wind, the fire, the trees, the animals and even the infectious diseases. He adopted various measures to please the deities. In short he lived in a world of superstitions.

With the increase in human intellect the reaction to forces of nature took a different turn. Plato introduced the theory that the world we see around us is not real, it is only a reflection of the world of reality: consequently the perceptual knowledge gained through the agency of human senses has no value. The theory had its effect all over the world. It had such a profound influence on human imagination that it affected the religious thought and gradually infilterated and subsequently replaced the Divine message revealed through Allah's messengers in different ages. Thus the world came to be considered an object of hate and a hindrance in the achievement of salvation.

This was the state of human mind before the Quran was revealed. The story of Adam (man) is allegorically related at various places in the Quran. It affirms the human status by the revolutionary proclamation that all the forces of nature are subservient to man :

وَإِذْ قُلْنَا لِلْمَلٰٓئِكَةِ اسْجُدُوْا لِاٰدَمَ فَسَجَدُوْٓا ...

(2:34)

"Then We said to the forces of nature: 'bow down to Adam' : and they bowed down."

It has already been stated that the biological definition of the status of 'man' has been, till recently, that stage of evolution at which the hominid started making tools.* Gradually the forces of nature bowed down before man one by one till it reached the stage of 'atom' and the conquest of outer space.

The Holy Quran says:

... وَسَخَّرَ لَكُمُ الْأَنْهَارَ ﴿٣٢﴾

(14:32)

"And the rivers and seas are subjected to you."

وَسَخَّرَ لَكُمُ الشَّمْسَ وَالْقَمَرَ دَائِبَيْنِ ... (14:33)

"And He has made subjected to you the sun and the moon, both diligently pursuing their courses."

... وَسَخَّرَ لَكُمُ اللَّيْلَ وَالنَّهَارَ ﴿٣٣﴾ (14:33)

"And the night and the day He has made subjected to you."

وَسَخَّرَ لَكُم مَّا فِي السَّمَاوَاتِ وَمَا فِي الْأَرْضِ جَمِيعًا مِّنْهُ ... (45:13)

"And He has made subjected to you all that is in the heavens and all that is in the earth."

As described earlier, all the phenomena of nature are bound down by certain laws. Man is required to gain knowledge of these laws and make use of the forces of nature. The Holy Quran lays great stress on gaining knowledge:

وَلَا تَقْفُ مَا لَيْسَ لَكَ بِهِ عِلْمٌ إِنَّ السَّمْعَ وَالْبَصَرَ
وَالْفُؤَادَ كُلُّ أُولَٰئِكَ كَانَ عَنْهُ مَسْئُولًا ﴿٣٦﴾

(17:36)

"Do not go after things of which you have no knowledge; for the ears and the eyes and the mind shall be questioned (if they made certain that so and so a thing was correct)."

Thus, according to the Holy Quran, knowledge is one that is gained by means of eyes, ears and intellect.

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*This definition no more stands good, as it has been found that chimpanzees also make tools, although of perishable material.

About those people who do not use their senses and do not apply their intellect, the Holy Quran says that they live in a hell, irrespective of the fact that they belong to a civilised or uncivilised population:

وَلَقَدْ ذَرَأْنَا لِجَهَنَّمَ كَثِيرًا مِّنَ الْجِنِّ وَالْإِنسِ ۖ لَهُمْ قُلُوبٌ لَّا يَفْقَهُونَ
بِهَا وَلَهُمْ أَعْيُنٌ لَّا يُبْصِرُونَ بِهَا وَلَهُمْ آذَانٌ لَّا يَسْمَعُونَ بِهَا ۚ أُولَٰئِكَ
كَالْأَنْعَامِ بَلْ هُمْ أَضَلُّ ۚ أُولَٰئِكَ هُمُ الْغَافِلُونَ ۝

(7:179)

> "Many are (amongst) the people (both) uncivilised and cilvilised, We have made for hell. They have minds where-with they understand not, eyes where-with they see not and ears where-with they hear not. They are like cattle,-nay more confused; for they are heedless (of warning)."

Then there is another set of people who make use of their intellect. About them the Holy Quran says:

إِنَّ فِي خَلْقِ السَّمَاوَاتِ وَالْأَرْضِ وَاخْتِلَافِ اللَّيْلِ وَالنَّهَارِ لَآيَاتٍ لِّأُولِي الْأَلْبَابِ
الَّذِينَ يَذْكُرُونَ اللَّهَ قِيَامًا وَقُعُودًا وَعَلَىٰ جُنُوبِهِمْ وَيَتَفَكَّرُونَ فِي خَلْقِ
السَّمَاوَاتِ وَالْأَرْضِ رَبَّنَا مَا خَلَقْتَ هَٰذَا بَاطِلًا سُبْحَانَكَ فَقِنَا عَذَابَ النَّارِ ۝

(3:190-191)

> "In the creation of the heavens and the earth and the alternation of day and night, there are indeed signs for men who think over it, men who keep before themselves the Divine law, standing, sitting and lying down on their sides and contemplate the (wonders of) creation in the heavens and the earth, (with the thought) our Lord: Thou hast not created all this without purpose. Praise be to Thee. Give us knowledge to discover the laws of nature to save ourselves from destruction."

The Holy Quran lays stress on the following two factors as they promote confirmation of belief in God:-

(a) To contemplate on the laws governing the phenomena of nature, with which you reach the conclusion that a supreme power with constructive designs is behind them.

(b) To contemplate on Quran which directed the humanity to explore nature and gain control over the forces of nature, at a time when man either bowed down before the natural forces or shunned the world, thinking it unreal.

Further, the Holy Quran describes certain categories of human beings. There are people who believe that, like all other animals, man consists of physical body only, which ends with the physical death. They do not believe in the application of Divine laws in human affairs. There are others who believe in the Quranic ideology and in the existence of human personality. According to them, the human body ends, but the human personality, when its potentialities are actualised, continues after physical death; and that this development of human personality is brought about by the application of Divine laws to the human affairs. Those belonging to the first category, after they gain knowledge of the natural laws, use this knowledge for their personal ends. On the other hand those belonging to the later category, use the knowledge gained about the laws of nature, for the benefit of humanity. Still there is another set of people who never pay attention to all that is going on in nature. They are bound to live in a life of hell.

The following verses make it clear:

إِنَّ فِي اخْتِلَافِ اللَّيْلِ وَالنَّهَارِ وَمَا خَلَقَ اللَّهُ فِي السَّمٰوٰتِ وَالْأَرْضِ لَاٰيٰتٍ لِقَوْمٍ
يَتَّقُونَ ۝ إِنَّ الَّذِينَ لَا يَرْجُونَ لِقَاءَنَا وَرَضُوا بِالْحَيٰوةِ الدُّنْيَا وَاطْمَأَنُّوا بِهَا
وَالَّذِينَ هُمْ عَنْ اٰيٰتِنَا غٰفِلُونَ ۝ أُولٰٓئِكَ مَأْوٰىهُمُ النَّارُ بِمَا كَانُوا يَكْسِبُونَ ۝ (10:6-8)

"In the alternation of night and day, and all that Allah created in the heavens and the earth, there are signs for those who save themselves from the consequences of going against the Divine laws.

There are those who do not hope to face the Divine laws and are satisfied with their present life.

And there are those who do not care for Our signs, their abode is fire, because of what they earned."

'Momin' and **'Muttaqi'**. Those who believe that the source of law, governing the physical world and that governing the human affairs is the same, are described as 'Muttaqi' in the verse described above. (Muttaqi is one who saves himself from the consequences of going the wrong way). These persons are also described as 'Momins'.

إِنَّ فِي السَّمٰوٰتِ وَالْأَرْضِ لَاٰيٰتٍ لِلْمُؤْمِنِينَ ۝ وَفِي
خَلْقِكُمْ وَمَا يَبُثُّ مِنْ دَآبَّةٍ اٰيٰتٌ لِقَوْمٍ يُوقِنُونَ ۝ (45:3-4)

"Verily in the ~~creation of~~ heavens and the earth are sings for those who believe. And in the creation of yourselves and in the fact that the walking animals are scattered (over the earth) are signs for those of assured belief."

Wise Men. The category of people described above are also referred to as wise men, because they are capable of making deductions from what they observe.

وَاخْتِلَافِ الَّيْلِ وَالنَّهَارِ وَمَا أَنْزَلَ اللّٰهُ مِنَ السَّمَاءِ مِنْ رِزْقٍ فَأَحْيَا
بِهِ الْأَرْضَ بَعْدَ مَوْتِهَا وَتَصْرِيفِ الرِّيٰحِ اٰيٰتٌ لِقَوْمٍ يَعْقِلُوْنَ ۝ (45:5)

"And in the alternation of night and day, and the fact that Allah sends down sustenance from above and thus gives life to earth after death, and in the circulation of winds, are signs for those who are wise."

Learned Men. As noted in the previous chapters, the Holy Quran refers to different phenomena of nature, in one context or the other, related to various branches of natural sciences physics, chemistry, astronomy, geology, botany and zoology etc. The Quran uses the words 'Learned Men' for those who have a knowledge of these sciences.

The verses already quoted in the chapter on 'pigments' are hereby reproduced:

أَلَمْ تَرَ أَنَّ اللّٰهَ أَنْزَلَ مِنَ السَّمَاءِ مَاءً فَأَخْرَجْنَا بِهِ ثَمَرٰتٍ مُّخْتَلِفًا أَلْوَانُهَا وَ
مِنَ الْجِبَالِ جُدَدٌ بِيْضٌ وَّحُمْرٌ مُّخْتَلِفٌ أَلْوَانُهَا وَغَرَابِيْبُ سُوْدٌ ۝ وَمِنَ النَّاسِ
وَالدَّوَآبِّ وَالْأَنْعَامِ مُخْتَلِفٌ أَلْوَانُهُ كَذٰلِكَ إِنَّمَا يَخْشَى اللّٰهَ مِنْ عِبَادِهِ الْعُلَمٰٓؤُا (35:27-28)
إِنَّ اللّٰهَ عَزِيْزٌ غَفُوْرٌ ۝

"Seest thou not that Allah sends down rains from the sky? With it We then bring out fruits of various colours, and in the mountains are tracts white and red of various shades of colour, and others intense black. And so amongst men and moving creatures and cattle, are they of various colours. Those of His servants who possess knowledge of these sciences, really appreciate the mighty powers of the laws of Allah. They know that the laws of Allah are omnipotent and provide protection for those who abide by it."

Fourteen hundred years ago the Holy Quran pointed towards certain regions which even now remain unexplored by the scientists. For example, there is a reference in the Holy Quran, to the existence of life on other heavenly bodies; and it has been pointed out that the living creatures living on different heavenly bodies shall come together in due course of time.

وَمِنْ اٰيٰتِهِ خَلْقُ السَّمٰوٰتِ وَالْأَرْضِ وَمَا بَثَّ فِيْهِمَا
مِنْ دَآبَّةٍ وَهُوَ عَلٰى جَمْعِهِمْ إِذَا يَشَآءُ قَدِيْرٌ (42:29)

"And among His significant signs are the creations of heavens and the earth and the moving creatures that He has scattered through

> them and He has measures to bring them together according to His plan".

We may summarise the impact of man's reaction to the forces of nature, on the rise and fall of nations, as follows:

1. Those people who gain knowledge of the natural phenomena by using their eyes, ears, and intellect and at the same time make use of the knowledge so gained for the benefit of humanity, belong to the class of 'Momins' and 'Muttaqis'. They have a bright present and a brighter future in this world and in the life hereafter.

2. Those people who explore nature and gain knowledge of the natural sciences but do not make use of it in the light of Divine guidance and do not apply it for the benefit of humanity, they do reach the stage of being a man, they do gain the pomp and glory of the present but they have no future before them.

3. Those who never attempt to explore nature at all, do not even reach the stage of being a man or *Adam* before whom the forces of nature bow down. They have a dark present and a dark future.

CHAPTER XVII

Permanent Values

الر ۚ كِتَابٌ أُحْكِمَتْ آيَاتُهُ ثُمَّ فُصِّلَتْ مِن لَّدُنْ حَكِيمٍ خَبِيرٍ (11:1)

"This (the Quran) is a code of life whose laws are based on PERMANENT VALUES, further explained in detail from One Who is Wise and Well-Acquainted (with all things)."

As described in the beginning of this book, the Holy Quran proves the truth of its fundamentals in the following ways:-

(1) The man is instructed to study carefully the history of the foregone nations and see that they rose when they acted according to revealed laws presented by the messengers of Allah, and fell from the pinnacle of their glory when they acted in the opposite way.

(2) Secondly, that if you go deep into the phenomena of nature and at the same time study the laws revealed to Allah's messengers, you get convinced that the source of law is one and one only. Thus the laws given to mankind by Allah are as immutable as the laws that govern the phenomena of nature.

(3) Thirdly, the Holy Quran impresses upon man the importance of a pragmatic test. You apply revealed laws to human affairs and watch the results yourself.

The previous pages of this book have been devoted to the description of the phenomena of nature. It is consistent with this description if we give here a brief summary of some of the Quranic fundamentals or immutable laws in support of which the Holy Quran draws attention, at every step, towards the 'Signs' in the heavens and the earth.

It may be mentioned here that these fundamentals are in the form of a boundary line for human action. Man is free to solve his day to day problems by means of his intellect, rather the Holy Quran impresses upon man at every step to use intellect; but that his decisions should remain within the four walls of the Permanent Values which are as follows:-

(1) Belief in One Allah. According to the Holy Quran belief in one Allah is neither an academic problem nor a dogmatic creed. It has a practical bearing on the day to day life of man. Belief in Allah means the acceptance of the sovereignty of Allah, or in other words it means the submission of one's actions to the will of Allah. The sovereignty of Allah according to the Quran reigns supreme in the universe, in the physical world as well as in the human affairs.

(47:19) لَآ إِلٰـهَ إِلَّا اللّٰهُ ...

"There is no sovereign except Allah".

(12:40) ... إِنِ الْحُكْمُ إِلَّا لِلّٰهِ ...

"The command is for none but Allah."

(18:26) ... لَا يُشْرِكُ فِي حُكْمِهِ أَحَدًا ۝

"Nor does He share His command with any one whosoever."

On the other hand, one who believes in Allah is subservient to only one command and that command is of Allah Himself:

(18:110) ... لَا يُشْرِكْ بِعِبَادَةِ رَبِّهِ أَحَدًا ۝

"In the subservience of his Sustainer, let no body admit any one as partner."

In the human world Allah exercises His command by means of revelation through his messengers!

(6:115) أَفَغَيْرَ اللّٰهِ أَبْتَغِي حَكَمًا وَّهُوَ الَّذِي أَنْزَلَ إِلَيْكُمُ الْكِتٰبَ مُفَصَّلًا ...

Say: "Shall I seek for judge other than Allah, when it is He Who has sent unto you the detailed book?"

Thus the sovereignty of Allah means the sovereignty of the book of Allah. This in turn is exercised through an organisation. The central command of the organisation of believers is an instrument to enforce the Divine law, and it is not allowed to exercise its personal authority.

(5:48) ... فَاحْكُمْ بَيْنَهُمْ بِمَآ أَنْزَلَ اللّٰهُ ...

"So judge between them according to what Allah has revealed."

Thus *the obedience to the central authority responsible for enforcing the Divine law and the unity of UMMAH*, i.e., the coordinated functioning of the social organisation of believers, are the natural consequences of belief in the One God.

(2) Belief in Human Personality. This is the basic belief upon which rest the other Permanent Values. As stated earlier, man is composed of two things, physical body and human personality. The physical body is controlled by the physical laws and human personality is controlled by the laws revealed through Allah's messengers. Physical body is destructible. On the other hand, human personalilty has got potentialities, which when actualised, make the developed personality indestructible.

The development of human personality is controlled by human actions. This is a world of cause and effect. Every action has got its reaction. In other words, every human action is rewarded. An act may be good or bad. A good act is one which is consistent with the Divine laws: a bad act is one which is inconsistent with the Divine laws. The Holy Quran says that the entire machinery of the universe has been created in order that no act of any human being remains unpaid:

وَخَلَقَ اللّٰهُ السَّمٰوٰتِ وَالْاَرْضَ بِالْحَقِّ وَلِتُجْزٰى كُلُّ
نَفْسٍ بِمَا كَسَبَتْ وَهُمْ لَا يُظْلَمُوْنَ ۝ (45:22)

> "Allah has created the heavens and the earth for constructive purposes and that every one be repaid for what he has earned, and that they will not be wronged."

A good act produces a positive or constructive effect on human personality and a bad act has a negative or disintegrating effect. The act may be manifest or concealed, it makes no difference. It requires no outside policing. The reaction is automatic as in other phenomena of nature. Even an idea that flashes across the mind, has its impact on the human personality:

يَعْلَمُ خَآئِنَةَ الْاَعْيُنِ وَمَا تُخْفِى الصُّدُوْرُ ۝ (40:19)

> "He knows the traitor of the eye and that which the bosoms hide."

فَمَنْ يَّعْمَلْ مِثْقَالَ ذَرَّةٍ خَيْرًا يَّرَهٗ ۝ وَمَنْ يَّعْمَلْ مِثْقَالَ ذَرَّةٍ شَرًّا يَّرَهٗ ۝ (99:7-8)

> "And he who does good (to the extent of) an atom's weight will see it then, and he who does ill to the extent of an atom's weight will see it then."

Thus the human body ends with the physical death, while the developed human personality passes on to its next evolutionary stage. This forms the basis of the belief in the Hereafter, and thus the basis of all other Permanant Values provided by Divine guidance.

(3) Respect for Humanity. All human beings are equal by birth and are worthy of respect:

(17:70) وَلَقَدْ كَرَّمْنَا بَنِيٓ اٰدَمَ ...

"We have honoured the humanity as a whole."

(4) Criterion of Position in Society. After birth the ranks are according to how far one's actions are consistent with the Divine laws:

(46:19) وَلِكُلٍّ دَرَجٰتٌ مِّمَّا عَمِلُوْا ...

"And to all are (assigned) degrees according to their deeds".

Accordingly the measure of greatness of an individual are his virtues.

(5) Slavery. No human being shall be a slave or a subject to his fellow beings. A man can only be subjected to Divine laws and not to any person, how highly placed that person may be, even as high as a messenger of Allah:

مَا كَانَ لِبَشَرٍ اَنْ يُّؤْتِيَهُ اللّٰهُ الْكِتٰبَ وَالْحُكْمَ وَالنُّبُوَّةَ
ثُمَّ يَقُوْلَ لِلنَّاسِ كُوْنُوْا عِبَادًا لِّيْ مِنْ دُوْنِ اللّٰهِ وَلٰكِنْ
(3:78) كُوْنُوْا رَبّٰنِيّٖنَ بِمَا كُنْتُمْ تُعَلِّمُوْنَ الْكِتٰبَ وَبِمَا كُنْتُمْ تَدْرُسُوْنَ

"It is not for any human being unto whom Allah had given the scripture and wisdom and the Divine Message, that he should afterwards have said unto mankind, 'Be slaves of me instead of Allah ...."

(6) Limitations to Human Actions. As described previously in the chapter on 'Levels of Organisation', the formation of a society means cooperation and loss of a certain degree of independence. In human society the degree and nature of this loss of independence is determined by law. According to Holy Quran this shall be determined by the revealed laws. The first part of verse 3:78 has been described above. " It is not for any human being unto whom Allah had given scripture and wisdom and the Divine Message, that he should afterwards have said unto mankind, 'Be slaves of me instead of Allah." The later part of the above verse is as follows:

"He should rather say, "Be faithful servants of your Rabb by virtue of the code of life that He has given you and which you teach one another and constantly study."

This means that the sovereignty shall only be of the Divine laws and not of any person, even if he is of such a high status as a messenger of Allah:

(7:3) اتَّبِعُوا مَا أُنزِلَ إِلَيْكُم مِّن رَّبِّكُمْ وَلَا تَتَّبِعُوا مِن دُونِهِ أَوْلِيَاءَ ...

"Follow that which is sent down to you from your Rabb and follow not any other protector besides Him".

Even the messenger of Allah shall have to follow the revealed laws:

(46:9) ... إِنْ أَتَّبِعُ إِلَّا مَا يُوحَىٰ إِلَيَّ ...

"I only follow that which is revealed to me".

(6:163) ... أَنَا أَوَّلُ الْمُسْلِمِينَ ۝

"I am the first to bow down before the Divine law."

(7) Adl. As described in the chapter on'Levels of Organisation", '*Adl*' means justice in all spheres of life. And justice means a condition where every individual in a human society gets what is due to him, not only economically but all the fundamental rights that belong to him by virtue of being a man. This provides equal opportunities to individuals for the physical development as well as the development of their personalities.

(16:91) إِنَّ اللَّهَ يَأْمُرُ بِالْعَدْلِ وَالْإِحْسَانِ ...

"Indeed Allah commands justice and proportion".

(8) Law of Equality. To act against the law knowingly, disturbs the rule of law. Thus punishment is prescribed for the crime through 'Qisas' (administration of Justice)."

(2:179) وَلَكُمْ فِي الْقِصَاصِ حَيَاةٌ يَا أُولِي الْأَلْبَابِ ...

"O ye men of understanding! in the law of Equality there is (the secret of collective) life for you."

(Qisas -- Life for life in case of murder) 2:178. But قصاص is not a personal act. It is the duty of the Government formed on the basis of Divine laws to prescribe and give punishment. The punishment should be proportionate to the crime committed:

(10:27) وَالَّذِينَ كَسَبُوا السَّيِّئَاتِ جَزَاءُ سَيِّئَةٍ بِمِثْلِهَا ...

"But those who have earned evil, will have a reward of like evil."

But one who apologises may be pardoned:

وَجَزٰٓؤُا سَيِّئَةٍ سَيِّئَةٌ مِّثْلُهَا ۚ فَمَنْ عَفَا وَأَصْلَحَ فَأَجْرُهُۥ عَلَى ٱللَّهِ ... (42:40)

> "The recompense of an injury is an injury equal thereto (in degree), but if a person forgives and makes reconciliation, his reward is due from Allah."

(9) Personal Responsibility. Justice demands that everybody should bear his own burden, i.e., he should personally fulfil his own responsibilities:

(6:165) ... وَلَا تَزِرُ وَازِرَةٌ وِزْرَ أُخْرَىٰ ...

> "No bearer of burden shall bear the burden of another."

Thus the consequences of one's act, cannot be transferred to another.

(10) Zulm. ظلم is opposite to *Adl* or justice. It means 'to put a thing at a place where it should not be'. The Quran not only prohibits wrong acts but also that you should not be wronged.

(2:279) ... لَا تَظْلِمُونَ وَلَا تُظْلَمُونَ ...

> "Wrong not and you shall not be wronged."

If every individual on his part avoids wrong acts, the wrong shall be eliminated from the society and all shall be protected against it. The verse also means that you gain so much strength that nobody may attempt to do wrong to you:

(22:39) أُذِنَ لِلَّذِينَ يُقَٰتَلُونَ بِأَنَّهُمْ ظُلِمُوا ...

> "Sanction is given unto those who fight because they have been wronged."

(11) Ehsan. The words *Adl* (Justice) and *Ehsan* come together in the Holy Quran. *Ehsan* is the next higher stage, in the Quranic social order, after Adl. As described earlier, Adl provides equal opportunities to individuals. On the other hand, Ehsan means a condition where an individual (if in spite of his best efforts) lags behind, his deficiency is made good by others to restore the disturbed proportion in the society. This is not by way of charity but as a matter of right.

إِنَّ اللَّهَ يَأْمُرُ بِالْعَدْلِ وَالْإِحْسَانِ ... (16:90)

"Allah commands justice and proportion (in society)."

(12) Justice in Courts of Law. The Holy Quran says:

(*a*) وَلَا تَلْبِسُوا الْحَقَّ بِالْبَاطِلِ وَتَكْتُمُوا الْحَقَّ وَأَنْتُمْ تَعْلَمُونَ ۝ (2:42)

"And confound not truth with falsehood, nor knowingly conceal the truth."

(*b*) (2:283) ... وَلَا تَكْتُمُوا الشَّهَادَةَ ...

"And hide not testimony."

(*c*) Appear as witness without any selfish motive, or any personal gain, or as a favour to somebody, or against enmity with anybody; but purely for the sake of truth:

يَا أَيُّهَا الَّذِينَ آمَنُوا كُونُوا قَوَّامِينَ بِالْقِسْطِ شُهَدَاءَ لِلَّهِ وَلَوْ عَلَىٰ أَنْفُسِكُمْ أَوِ الْوَالِدَيْنِ
وَالْأَقْرَبِينَ ۚ إِنْ يَكُنْ غَنِيًّا أَوْ فَقِيرًا فَاللَّهُ أَوْلَىٰ بِهِمَا ۖ فَلَا تَتَّبِعُوا الْهَوَىٰ أَنْ
(4:135) تَعْدِلُوا ۚ وَإِنْ تَلْوُوا أَوْ تُعْرِضُوا فَإِنَّ اللَّهَ كَانَ بِمَا تَعْمَلُونَ خَبِيرًا ۝

"Oh you who believe! Be you staunch in justice, give evidence for Allah even though it goes against yourself or (your) parents or (your) kindred, whether (the case be of) a rich man or a poor man, for Allah is nearer to both (than you are). So follow not passion lest you lapse or fall away. For lo! Allah is ever informed of what you do.

(*d*) To do justice in a favourable or neutral atmosphere is meritorious enough but the real test comes when you have to do justice to people who hate you or who are your enemies:

يَا أَيُّهَا الَّذِينَ آمَنُوا كُونُوا قَوَّامِينَ لِلَّهِ شُهَدَاءَ بِالْقِسْطِ ۖ وَلَا يَجْرِمَنَّكُمْ شَنَآنُ قَوْمٍ
عَلَىٰ أَلَّا تَعْدِلُوا ۚ اعْدِلُوا هُوَ أَقْرَبُ لِلتَّقْوَىٰ ۖ وَاتَّقُوا اللَّهَ ۚ إِنَّ اللَّهَ خَبِيرٌ بِمَا تَعْمَلُونَ ۝ (5:8)

"Oh you who believe! Stand out firmly for Allah, as witnesses to fair dealing and let not the hatred of others make you swerve to wrong and depart from justice. Be just. That is nearer to the path. Allah leads to. Uphold the path of Allah. Allah's law of مكافات is well-acquainted with what you do."

(*e*) Do not plead the cause of those who do wrong:

(4:105) ... وَلَا تَكُنْ لِّلْخَآئِنِيْنَ خَصِيْمًا ۝

"So be not (used) as an advocate by those who betray their trust."

One who deceives others, thinks that he has gained something. In fact he has lost something, on account of the destructive effect on his own personality. Actually he has deceived himself. To plead the cause of such people is prohibited:

(4:107) وَلَا تُجَادِلْ عَنِ الَّذِيْنَ يَخْتَانُوْنَ اَنْفُسَهُمْ ...

"Fight not the cause of those who betray their own souls."

(28:17) ... فَلَنْ اَكُوْنَ ظَهِيْرًا لِّلْمُجْرِمِيْنَ ۝

"I shall nevermore be a supporter of the guilty."

(13) Enforcement of Law. امر بالمعروف ونہی عن المنکر It is the duty of Quranic social order to enforce what is lawful according to Divine law and prohibit what is unlawful. In other words the Do's and Dont's are not a matter of preaching. They are rather to be made the law of the country.

(3:109) كُنْتُمْ خَيْرَ اُمَّةٍ اُخْرِجَتْ لِلنَّاسِ تَاْمُرُوْنَ بِالْمَعْرُوْفِ وَتَنْهَوْنَ عَنِ الْمُنْكَرِ ...

"You are the best of community that has been raised up for mankind. You enjoin what is right and forbid what is wrong.

(14) Lawlessness is Prohibited:

(2:205) ... وَاللّٰهُ لَا يُحِبُّ الْفَسَادَ ۝

"Allah loveth not lawlessness."

(15) Permanent Values a Boundary Line for Human Actions. The Permanent Values described in the Quran form the basis of Quranic social order. But they only provide the boundary line. The day to day problems are discussed and solved, within the four-walls of these Permanent Values or Quranic Fundamentals, by mutual consultation.

(42:38) ... اَمْرُهُمْ شُوْرٰى بَيْنَهُمْ ...

"Who (conduct) their affairs by mutual consultation."

Even the messenger of Allah is no exception to it.

(3:158) ... وَشَاوِرْهُمْ فِي الْأَمْرِ ...

"(O Messenger of Allah) Consult them in affairs (of moment).

(16) Render Back the Trusts:

إِنَّ اللَّهَ يَأْمُرُكُمْ أَنْ تُؤَدُّوا الْأَمٰنٰتِ إِلَىٰ أَهْلِهَا وَإِذَا
(4:58) حَكَمْتُمْ بَيْنَ النَّاسِ أَنْ تَحْكُمُوا بِالْعَدْلِ ...

"Verily Allah commands you to render back your Trusts to whom they are due; and when you judge between man and man, that you judge with justice."

The Holy Quran lays great emphasis on rendering back the trusts to whom they are due. The trust may be an ordinary deposit. On the other hand 'the reigns of power' being the biggest and most sacred trust that any human beings can entrust to their fellow human-beings, it is imperative that those who are given power must be most trustworthy and most fit persons, those who are capable of deciding the human affairs with full justice and thus fulfil the responsibilities entrusted to them.

(17) Subsistence. Nourishment of individuals is the responsibility of the state:

(22:41) الَّذِينَ إِنْ مَكَّنّٰهُمْ فِي الْأَرْضِ أَقَامُوا الصَّلٰوةَ وَآتَوُا الزَّكٰوةَ ...

"Those who, if We establish them in the land, establish a social order based on Divine law and provide nourishment (to the individuals).

(18) Contract between an Islamic state and the believers. In a Quranic Social order the state becomes a symbol of Divine attributes guaranteeing fulfilment of Allah's promises. Thus the life and property of the believers are at the disposal of the state; and in lieu of it, it is the responsibility of the state to provide peace and plenty to the individuals i.e., heavenly life on the earth.

(9:111) إِنَّ اللَّهَ اشْتَرٰى مِنَ الْمُؤْمِنِينَ أَنْفُسَهُمْ وَأَمْوَالَهُمْ بِأَنَّ لَهُمُ الْجَنَّةَ

"Allah has purchased of the believers, their persons and their wealth, surely for them is a heavenly life (in return)".

(19) Sources of production are for the benefit of humanity as a whole.

(2:29 هُوَ الَّذِي خَلَقَ لَكُم مَّا فِي الْأَرْضِ جَمِيعًا ...

"It is He Who has created all that is in the earth, for your collective benefit."

(7:10) وَلَقَدْ مَكَّنَّاكُمْ فِي الْأَرْضِ وَجَعَلْنَا لَكُمْ فِيهَا مَعَايِشَ ...

"It is We Who have given you the authority on the earth and provided you (humanity) therein the means for the fulfilment of your life."

It is further said that:-

(41:10) ... سَوَاءً لِّلسَّائِلِينَ ۝

"Means of Sustenance belong equally to all who need them".

(20) All that is surplus to the need of an individual belongs to the society:

(2:219) ... يَسْأَلُونَكَ مَاذَا يُنفِقُونَ قُلِ الْعَفْوَ ...

"They ask thee how much they are to spend (for the benefit of others); say: what is surplus' (to your legitimate needs)."

This spending on others is not by way of charity but by way of their human right. Those who, in compliance with the above injunction of the Holy Quran, give their surplus to the needy, simultaneously declare:-

(76:9) إِنَّمَا نُطْعِمُكُمْ لِوَجْهِ اللَّهِ لَا نُرِيدُ مِنكُمْ جَزَاءً وَلَا شُكُورًا ۝

"We provide you with the means of sustenance only because it is prescribed by the Divine law. We do not intend to receive any personal benefit from you, nor any thanks."

(21) Giving to others promotes the nourishment and stability of your own personality:

(2:265) ... تَثْبِيتًا مِّنْ أَنفُسِهِمْ ...

"For the stability of their personality."

(22) Usury. An economy based on interest is disallowed. The Holy Quran says:

(2:275) ... اَحَلَّ اللّٰهُ الْبَيْعَ وَحَرَّمَ الرِّبٰوا ...

"Allah hath permitted trade and forbidden usury."

The Quran condemns and prohibits usury in the strongest terms and differentiates between trade and usury. The Quran only allows a return in lieu of one's labour. In trade one puts in both capital and labour, while in usury only capital is spent. Thus interest on capital is disallowed while genuine profit in trade is allowed. Every type of profiteering is usury.

(23) Chastity. Sexual relationship between a man and a woman, outside the bonds of matrimony is strictly forbidden.

(17:32) وَلَا تَقْرَبُوا الزِّنٰى اِنَّهٗ كَانَ فَاحِشَةً وَسَآءَ سَبِيْلًا ٥

"And come not near adultery. Lo! It is an abomination and an evil way."

Marriage is a contract between two adults by mutual consent only. It is not allowed to compel some one for marriage.

(4:19) يٰٓاَيُّهَا الَّذِيْنَ اٰمَنُوْا لَا يَحِلُّ لَكُمْ اَنْ تَرِثُوا النِّسَآءَ كَرْهًا ...

"Oh you who believe! It is not lawful for you to become masters of women forcibly."

(24) Universal Broltherhood:

(10:19) وَمَا كَانَ النَّاسُ اِلَّآ اُمَّةً وَّاحِدَةً فَاخْتَلَفُوْا ...

"Mankind were but one community, then they differed."

To reorganise universal bortherhood, the Holy Quran has prescribed one fundamental code of life for the humanity. In other words one world Government:

(10:57) يٰٓاَيُّهَا النَّاسُ قَدْ جَآءَتْكُمْ مَّوْعِظَةٌ مِّنْ رَّبِّكُمْ ...

"Oh mankind there has come to you a (common) code of life."

(25) The Survival of the Constructive. The welfare work may be confined within parties, countries or nations. According to the Holy Quran only that which is beneficial for the entire mankind, survives:

... وَأَمَّا مَا يَنفَعُ النَّاسَ فَيَمْكُثُ فِي الْأَرْضِ ... (13:17)

"All that is beneficial to the humanity stay on the earth."

As a first step towards achieving this goal, the Holy Quran directs mankind to cooperate with one another without distinction of race, colour, country or nation; in those affairs which are constructive and based on Permanent Values; and not in those affairs which are destructive and unlawful:

... وَتَعَاوَنُوا عَلَى الْبِرِّ وَالتَّقْوَىٰ وَلَا تَعَاوَنُوا عَلَى الْإِثْمِ وَالْعُدْوَانِ ... (5:2)

"You cooperate with one another in matters of broadmindedness and matters consistent with the Divine law, and do not cooperate in matters of sin and enmity."

(26) Division of Mankind. Distinction between man and man on the basis of caste, colour, race and language, is forbidden. According to the Holy Quran, there is only one criterion for the division of mankind. That division is on the basis of ideology. Those who believe in the Permanent Values of Quran belong to one group. Those who do not believe in them belong to another.

هُوَ الَّذِي خَلَقَكُمْ فَمِنكُمْ كَافِرٌ وَمِنكُم مُّؤْمِنٌ ... (64:2)

"It is He Who has created all of you, some of you are non-believers and some of you are believers."

(27) Freedom of Choice. There is no compulsion for belief in the Quranic Fundamentals. A decision that is not wilful is not a decision. Thus non-believers are under no compulsion to join the ranks of believers.

لَا إِكْرَاهَ فِي الدِّينِ قَد تَّبَيَّنَ الرُّشْدُ مِنَ الْغَيِّ ... (2:256)

"There is no compulsion (to follow) the way of life based on Quranic fundamentals. The right direction is henceforth distinct from error."

Thus there is freedom of choice whether one follows this way or that way:

وَقُلِ الْحَقُّ مِن رَّبِّكُمْ فَمَن شَاءَ فَلْيُؤْمِن وَمَن شَاءَ فَلْيَكْفُرْ (18:29)

"Say: (It is) the truth from the Sustainer of you (all). Then whosoever will, let him believe, and whosoever will, let him disbelieve."

In a social order based on Quranic Fundamentals, it is not only that the non-believers are allowed to disbelieve but the Holy Quran enjoins upon believers to protect the non-believers and their places of worship:

... وَلَوْلَا دَفْعُ اللَّهِ النَّاسَ بَعْضَهُم بِبَعْضٍ لَّهُدِّمَتْ صَوَامِعُ وَ
بِيَعٌ وَّصَلَوٰتٌ وَّمَسَٰجِدُ يُذْكَرُ فِيهَا اسْمُ اللَّهِ كَثِيرًا ... (22:40)

"Had not Allah checked one set of people by means of another, there would surely have been pulled down monasteries, churches, synagogues and mosques in which the name of Allah is commemorated in abundant measures."

But it is important to note that when one willingly joins the Quranic social order, then it remains no more optional to follow this law or that. Then he is bound to follow the Quranic law.

(28) Defence of the social order by raising arms. Believers are commanded to raise arms for the defence of the Quranic social order.

وَقَاتِلُوا فِي سَبِيلِ اللَّهِ الَّذِينَ يُقَاتِلُونَكُمْ وَلَا تَعْتَدُوا إِنَّ اللَّهَ لَا يُحِبُّ الْمُعْتَدِينَ (2:190)

"Fight in the cause of Allah, those who fight you. But do not transgress limits, for Allah loveth not the transgressors."

The transgression here means using force for compelling others to accept Islam as their 'Deen'.

(29) Hijra. According to the Holy Quran it is the duty of a messenger of Allah as well as a believer, to strive hard for the establishment of a social order based on the Divine Law. His first step would be to establish it at the place of his birth. But if inspite of his best efforts the circumstances around him are not amenable, he leaves this place and migrates to another land where he finds suitable environments. His objective is to establish a social order and not to worship a particular localitly. The choice lies between his wealth, property, relations and place of birth on one hand; and the Quranic social order on the other. He chooses the latter and sacrifices the former. This type of migration is termed by the Holy Quran as "Hijra". It is not a migration in search of food or wealth, nor is it an escape from facing difficulties; it is rather a more feasible and practicable procedure and a part of his struggle to establish the Quranic social order. That is why the words ' هاجرو . , and ' جاهدو' often come together in the Holy Quran:

(2:218) ... وَالَّذِينَ هَاجَرُوا وَجَٰهَدُوا فِي سَبِيلِ اللَّهِ ...

"Those who emigrated and strove in the way of Allah."

'Hijra' is a part of 'Jihad', or rather the best part of it.

The above brief description represents the more prominent and main Fundamental Principles that one comes across during the study of the Holy Quran. These principles were proclaimed to the world, fourteen centuries ago, by an unlettered orphan (peace be upon him) who belonged to a backward, uneducated, unskilled, and undisciplined community of idol-worshippers of Mecca. He was born at a time when the edifice of the world civilisation, that was built through the past 4000 years, was razed to the ground; when despotism was the rule of the day; when superstition dominated the human thought; when every tribe was thirsty of the other's blood; when the way of life, prescribed by the Messengers of the past throughout the world, which was meant to produce peace and integration, was thrown overboard, and was replaced by chaos and disruption. In short that was the time when the forces of disintegration prevailed upon the entire human society inhabiting the globe.

The principles described above are immutable and provide guidance for the development of human personality as well as the smooth running of the human society, as truly today as they did 1400 years ago; and they shall remain as such for all times to come. Anything constructive that we find in the human world today, is in consonance with these principles; and anything positive, constructive and lasting that Man is in search of, shall be available from this very source. Anything repugnant to this code of life, is bound to be negative, destructive and perishable. The more a nation follows the above-said principles, the more it pulsates with life; the more a nation forsakes them, the more it is full of misery and disappointment. Any unbiased observation and any pragmatic test can prove the truth of this assertion. In the words of Iqbal:

ہر کجا بینی جہانِ رنگ و بو   آنکہ از خاکش بروید آرزو
یا ز نورِ مصطفیٰ او را بہاست   یا ہنوز اندر تلاشِ مصطفیٰ است

"Wherever you find a world displaying life and beauty, from the soil of which blossom sublime aspirations; it has either already received light from Muhammad (peace be upon him), or is still in search of that light."

The immutability of these principles and the circumstances under which they appeared on the earth is a positive proof that they were revealed to the one who was entrusted with the responsibility of their transmission to humanity and that they came from the same source from which the immutable laws that control the phenomena of nature, originated.

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

اَلْحَمْدُ لِلّٰهِ الَّذِیْٓ اَنْزَلَ عَلٰی عَبْدِهِ الْكِتٰبَ وَلَمْ
يَجْعَلْ لَّهٗ عِوَجًا ۜ قَيِّمًا لِّيُنْذِرَ بَاْسًا شَدِيْدًا
مِّنْ لَّدُنْهُ وَيُبَشِّرَ الْمُؤْمِنِيْنَ الَّذِيْنَ يَعْمَلُوْنَ
الصّٰلِحٰتِ اَنَّ لَهُمْ اَجْرًا حَسَنًا ۝

"Praise be to Allah, Who hath revealed to His servant this code of life, with nothing irregular or ambiguous finding a place therein. He hath made it straight, explicit and balanced; to warn those who do not believe in it, of the terrible consequences of going the wrong way; and give glad tidings to the believers who work deeds that promote the development of their potentialities and the formation of a balanced society, that they shall have an excellent and goodly reward."

THE LAST WORD

... رَبَّنَا مَا خَلَقْتَ هٰذَا بَاطِلًا سُبْحٰنَكَ فَقِنَا عَذَابَ النَّارِ ۝ (3:191)

"Our Rabb! You have not created all this without purpose. Glory to Thee! Give us knowledge to discover the laws of nature, to save ourselves from destruction."*

"Science is in its source eternal, in its scope unmeasurable, in its problem endless, in its goal unattainable." (*Von Baer*)

I have attempted to describe in this book, certain phenomena of nature with reference to relevant 'Ayat' (significant signs) as contained in the Quranic text. I fully realise my limitations as far as the knowledge of Quran, as well as of science, is concerned. As a matter of fact it is not possible for any human being to know all or even a substantial part of the natural phenomena around us. The number of phenomena visible to the naked eye and those discovered by the scientific research and explorations, is so great that possibly one cannot even enumerate them; and this forms only a small fraction of what still lies undiscovered. That is why the Holy Quran has said:

وَلَوْ أَنَّ مَا فِي الْأَرْضِ مِنْ شَجَرَةٍ أَقْلَامٌ وَالْبَحْرُ يَمُدُّهُ مِنْ
بَعْدِهِ سَبْعَةُ أَبْحُرٍ مَا نَفِدَتْ كَلِمٰتُ اللّٰهِ إِنَّ اللّٰهَ عَزِيزٌ حَكِيمٌ ۝ (31:37)

"And if all the trees of the earth were pens and the oceans (were ink) with seven oceans behind it to add to its (supply) yet would not the (infinite) signs of Allah be exhausted; for Allah is exalted in power and full of wisdom."

On the other hand, one can interpret the Holy Quran only to the extent of the knowledge he possesses. The more the human knowledge advances, the more the meaning of the Quranic text becomes clear and the more one gets convinced of the truth of the Quranic Fundamentals. Thus it is imperative that in order to understand the Quran, besides other things, one should be sufficiently conversant with the contemporary scientific knowledge. The Quran thus serves as a guide to mankind for all ages.

*Rabb--One who initiates, sustains and evolves to the stage of final destination.

As I mentioned in the introductory paragraphs of this book, stagnation in the scientific knowledge and research amongst Muslims started only after they forsook the guidance of the Quran which lays great stress upon man to explore nature. The impetus of the Quran having gone, it resulted in their decline in every sphere of life. Today in the glimmer of Western scientific research, the glory of our past is hardly recognisable. So much so that we are made to think that the scientific research started only three centuries earlier. The tremendous strides that the West took in the field of science during the last two centuries are too well known. But on the other hand it cannot be denied that Muslims were the pioneers in the field of science. They made great contributions to the scientific thought in Middle Ages, and this exerted an immense influence on the study of science in Europe in later centuries.

I hereby mention the names of certain Muslim scientists and research scholars whose scientific works and writings were later on translated into various European languages. The sequence of names, given below against various subjects, is more or less according to the various periods in which they lived respectively and not in order of their fame and work in the respective fields.

Astronomy.--Ibrahim Farazi, Yaqoob bin Tariq Naubakht, Masha-Allah, Fazal-bin-Naubakht, Yahya-bin-Mansoor, Sanad-bin-Ali, Khalid-bin-Abdul Malik, Ali-bin-Isa, Umar-bin-Farhan, Ahmad-Kaseer-Ferghani, Muhammad-bin-Jabbir-Albatani, Fazal Nairezi, Muhammad Hidazi, Abdullah Turki, Abdul Aziz Qaisi, Hamid Khujandi, Abdur Rahman Soofi, Muslima Behreti, Ibrahim Zarqali, Ibn Yunus.

Chemistry.--Jabir-bin Hayyan (The first chemist in History), Muhammad Kasi, Razi, Avicenna.

Medicine.--Jarjees-bin-Jabrael, Hunain-bin-Ishaq-Yuhanna-bin-Maswia (optics), Yoqoob Kindi (Geometrical optics), Ali bin-Suhal Ribin, Abu Bakr Muhammad Ibn Zakraya ar-Razi (wrote about 150 books and pamphlets), Abu Mansoor Mofiq, Abu al-Jazar, Ahmad Jabari, Ali-bin-Abbas, Areeb Qartabi (Obstetrics), Suleman Jaljal, Ibnul Wafid, Abul Qassim Alzahrawi, Muhammad bin-Ahmed Tamimi, Ahmad Biladi, Masawia Mardani, Abul Qassim Ammar bin Ali Moosli (Cana Musali) (optics), Ali-bin-Musa (optics), Ibn-al-Haitham (Alhazen) (optics), Abu-Sahal-Mesehi, Bu-Ali-Sina (Avicenna), Saeed bin Habatullah, Ibn Fazl, Zarreen Dast (optics).

Biology. Abdul-Malik-bin-Qareeb-Asmaee.

Physics and Mathematics.--Muhammad bin-Musa, Ahmad bin-Musa, Hasan bin-Musa (three brothers).

Mathematics.--Ali-bin-Saeed, Hajjab-bin-Yousuf-bin-Matar, Abu Saeed Zarir Jarjani, Habsh-al-Hasab, Muhammad-bin-Musa-Khwarzami (Algebra and Arithmetic), Sabit-bin-Qara, Ahmad-bin-Yusuf Misri, Ahmad-bin-Suhail Balkhi, Ali Imrani, Saeed Damishqi, Ibrahim-bin-Sabit, Jafar-Al-Khazan, Abul-Wafa Buzjani, Hamid Khujandi, Wayan-bin-Rustam Kohi, Ahmad Sajistani, Alberuni, Muhammad Hasab Karkhi, Koshiar, Ali Niswi.

"*Namwar Muslim Sainsdan*" (Famous Muslim Scientists--by Prof. Hamid Askari.)

Now let us give a brief description of just a few of them.

Abul Qassim Al-Zahrawi (936-1013) :-

He was the greatest physician and surgeon of his time and the greatest Arab Surgeon of all times. At a time when a physician was also a philosopher, a theologian, a mathematician, an astronomer, a linguist, and a universal scholar, Abul-Qassim advocated specialization and tended to adhere to medicine and its practice alone. His work *Al-Tasrif*, an illustrated practice of medicine and surgery, a real miniature encyclopaedia of 1500 pages shows Abul Qassim to be not only a medical scholar but a great practising physician and surgeon. The rich contents of *Al-Tasrif* exerted an immense influence on the study of medicine and the progress of Surgery in Europe in the later centuries. In *Al-Tasrif* are revealed Abul Qassim's moral honesty and integrity, his professional dignity and ingeniousness. The book contains descriptions and the earliest pictures in history of about 200 surgical instruments and these were devised by Abul Qassim himself (Fig. 112). Of all the 30 volumes of *Al-Tasrif*,

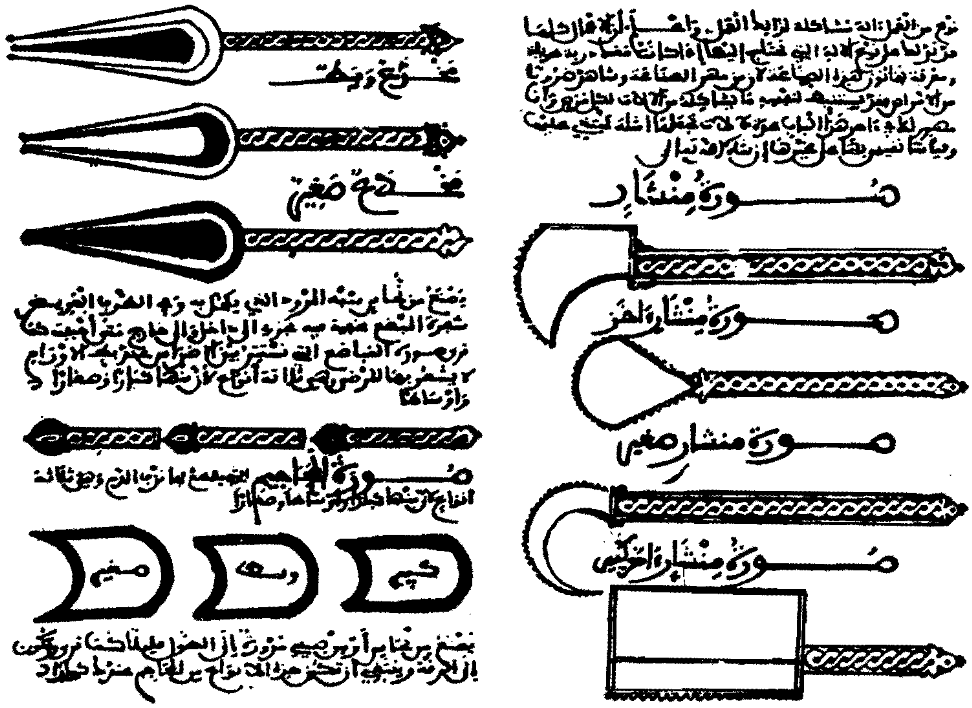

Fig.112.--Page from Al-Tasrif showing some of the Instruments invented by ABUL QASSIM AL-ZAHRAWI (936-1013).

discourse 30 on surgery became the most famous and had by far the widest and greatest influence. Almost all the European authors of surgical texts from the 12th to

Fig. 113—AVICENNA

the 16th centuries, referred to Abul Qassim's surgery and copied from it. Discourse 28 is on Pharmacy and was translated into Latin as early as 1288 as Liber Servitoris. It was the fourth medical book ever printed. Today 42 manuscript copies of his original Arabic text and 27 Latin translations in manuscript are treasured in the most important libraries and museums of the world; at least 27 printed editions of his book in Latin, Arabic, French, English and Spanish adorn the rare collections of the most famous libraries; and surgeons all over the world still perform numerous surgical procedures and operations little realising that they were introduced by Abul Qassim 1000 years ago. (Extract from article by Dr. Farid Sami Haddad, Beirut).

Avicenna (980-1037) -- (Fig. 113)

Amongst the brilliant contributors to the sciences of Pharmacy and Medicine during the Arabian era was one genius, the Persian Abu Ali Hussain Ibn Abdulla Ibn Sina, known in the Western world as Avicenna. He was called '*Prince of physicians*' by his contemporaies but he was much more than that. Pharmacist, physician, poet, philosopher, writer, orator and diplomat, Avicenna was an intellectual giant. He was well versed in all contemporary knowledge. His pharmaceutical teachings were accepted as authoritative in the West until the 17th century and still are dominant influences in the Orient.

Avicenna learnt Quran by heart at the age of 10. At the age of 16 he had not only mastered philosophy and sciences but had already made a name for himself as a physician. At the age of 18 he wrote a comprehensive treatise embracing all branches of science. He wrote over 100 books on Islamic teachings, metaphysics, astronomy, philosophy, political questions and medicine. His most important work was the 'Qanon of Medicine', a treatise in five volumes. This was of such an exhaustive nature and so perfect in its conception that it remained a standard work for several hundred years and was still used for teaching purpose at the universities of Montpelliar and Louvain until well into the 17th century. The translation into Latin by Gerard-de-cremone had been universally popular. The 'Qanon' offers a surprising harvest of ideas and notes on surgery that are not yet out-dated, and it reflects the guiding principle of Avicenna's life -- the attempt to comprehend all the various manifestations of the physical and spiritual world and to bring them together in a harmonious whole. In all 30 editions of 'Qanon' were published, the first in Milan in 1413 and the last in Louvain in 1658.

Avicenna's encyclopaedic knowledge, his enormous productivity and his genius in so many different fields have ensured him a place as one of the greatest sages in the annals of mankind.

Alhazen: Abu Ali al-Hasan bin Hussain Ibn-al-Haitham (965 1043) (Fig. 114).

Known in the Western world as Alhazen, he was a Muslim scientist of repute. Born in Basra, he made a name in Mathematics, Astronomy, Civil Engineering and especially in Physics and Optics. He was the first to survey and plan the construction of Aswan Dam on river Nile 1000 years ago but the project could not be attempted on account of the insufficient means then available. His famous book *Kitab al-Manazir* was the first comprehensive book on 'Light' (Physics) and Optics. In it he described the similarity in nature of heat and light rays. The book contains the first correct exposition of the Theory of Vision. It explains the various aspects of light, such as colours, optic illusions and reflection, mirrors, twilight, rainbow, halo etc. It introduced for the first time the two laws of refraction. Alhazen also described such things as force of gravity, velocity, space, atmosphere and density. He thus laid the foundation of Physics in general and Optics in particular and paved the way for future research on the subject by later scientists.

Alhazen described the naked eye, anatomical features of the human eye, in sufficient details.

The original Arabic manuscript text of Kitab al-Manazir is not available, though the Latin translation and its dependent English translation is still present in different parts of the world.

Muhammad Bin Zakriya Razi (840-932)

He was known in the West as Rhazes. Born in Rey near Tehran. Was a preeminent physician and a chemist. As a chemist his name comes next to Jaber Bin Hayan (known as Geber in the West -- born 722, the first chemist in history). Razi wrote 21 books and pamphlets on chemistry. He was the first to classify chemistry as organic and inorganic. He discovered the specific gravities of various substances, by means of an apparatus similar to the modern hydrostatic balance.

But Razi's greatness in the field of science lay in his being a physician of great calibre. His literary works on medicine are more than one hundred, of which 'Hawi' was the most famous one and had its greatest influence in the East and the West. It was a medical encyclopaedia, which was compiled after his death by his pupils from the notes which he had been writing all his life long. At least 25 copies of its Latin translation are now treasured in the western libraries. The first translation appeared in Persia in 1489 and the second in Venice in 1542. His other well-known medical work is 'Almansoori'. Though concise, it was even more popular. Its Latin translation, entitled 'Liber Almonsoris' was first published in Leiden in 1481, then in Venice in 1497 and again in Basel in 1544. Razi also wrote a number of pamphlets on various medical subjects; such as "Dietetic treatment of diseases"; "Stone in kidneys and urinary bladder", the French translation of which appeared in Leiden in 1896; "Colic"; "Differential diagnosis of diseases" etc. But the one that gained most popularity was on "Smallpox and Measles" entitled كتاب الحدرى والحصبة . Its Latin translation was published in Venice in 1445 and English translation in London

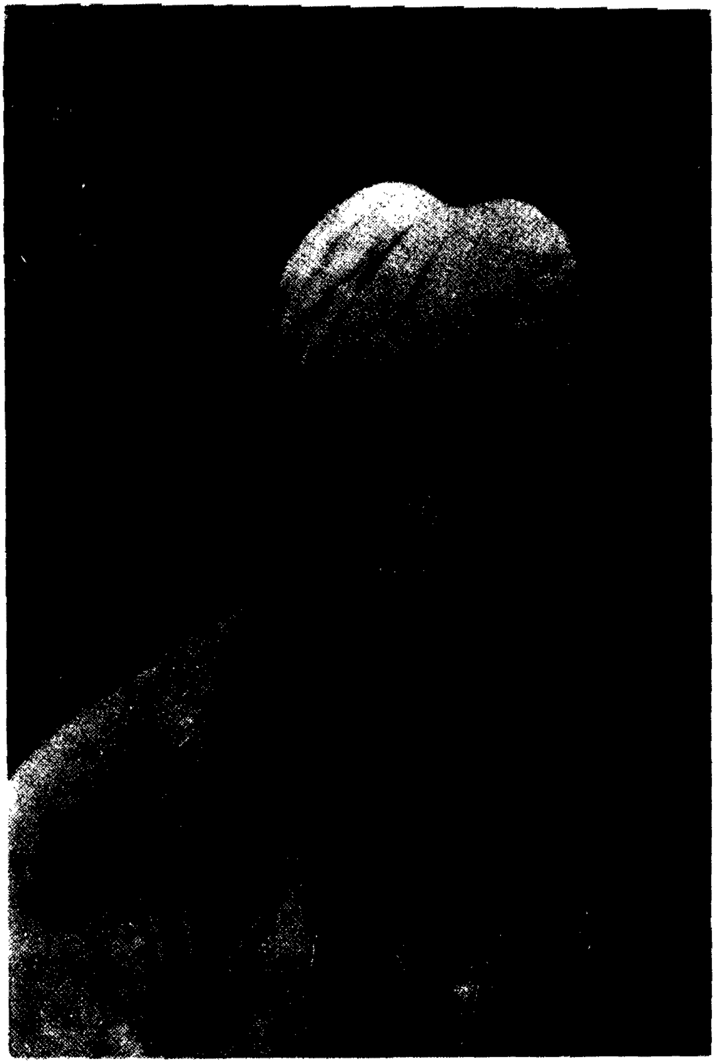

Fig. 114 -- ALHAZEN.

in 1848. This was the first book in the world that described in details the causes, signs and symptoms, treatment and the prophylactic measures against Smallpox and Measles.

This is just a glimpse of our glorious past in the field of scientific knowledge and research.

At every step the Holy Quran enjoined upon Muslims to explore nature, to ponder over the 'Ayat' or 'significant signs' that lie scattered all over the universe. This provided a stimulus for their activities and made them the super-nation of the world. The stimulus having gone they fell into an abyss, according to the law of rise and fall of nations, as enunciated in the Holy Quran. It is now for the Muslim youth of the world to turn back towards the Quran and also dive deep into the scientific research to regain their past glory, by the application of science to the benefit of humanity.

وَفِي الْأَرْضِ آيٰتٌ لِّلْمُوقِنِينَ وَفِي أَنفُسِكُمْ أَفَلَا تُبْصِرُونَ ۝ (51:20-21)

"In the earth are clear 'signs' for those who get convinced (after thorough investigation and research); and also within yourself. THEN, WILL YOU NOT EXERCISE YOUR VISION?"

It is only a question of turning towards the Holy Quran, which has got a tremendous appeal for those who think over it. Human beings are bestowed with the faculties of intellect, understanding and appreciation. But if these faculties were given to an inanimate object, that even could not remain unaffected by the Message of the Quran. This assertion is beautifully stated in the Holy Quran itself, when it said:

لَوْ أَنزَلْنَا هٰذَا الْقُرْآنَ عَلٰى جَبَلٍ لَّرَأَيْتَهُ خَاشِعًا مُّتَصَدِّعًا مِّنْ خَشْيَةِ اللّٰهِ وَتِلْكَ
الْأَمْثَالُ نَضْرِبُهَا لِلنَّاسِ لَعَلَّهُمْ يَتَفَكَّرُونَ ۝ هُوَ اللّٰهُ الَّذِي لَا إِلٰهَ إِلَّا هُوَ عٰلِمُ الْغَيْبِ وَ
الشَّهَادَةِ هُوَ الرَّحْمٰنُ الرَّحِيمُ ۝ هُوَ اللّٰهُ الَّذِي لَا إِلٰهَ إِلَّا هُوَ الْمَلِكُ الْقُدُّوسُ السَّلٰمُ
الْمُؤْمِنُ الْمُهَيْمِنُ الْعَزِيزُ الْجَبَّارُ الْمُتَكَبِّرُ سُبْحٰنَ اللّٰهِ عَمَّا يُشْرِكُونَ ۝ هُوَ اللّٰهُ
الْخٰلِقُ الْبَارِئُ* الْمُصَوِّرُ لَهُ الْأَسْمَاءُ الْحُسْنٰى يُسَبِّحُ لَهُ مَا فِي السَّمٰوٰتِ وَالْأَرْضِ
(59:21-24) وَهُوَ الْعَزِيزُ الْحَكِيمُ ۝

"The effective power of this Quran is such that if, for example, We had placed it in the heart of a mountain and had given it the feelings, the mere idea of infringing the Divine laws would have shaken it to the roots and it would have cleft itself asunder, for not being equal to such a tremendous Trust. Such are the similitudes that We offer to men, that they may reflect thereon and realise the immense greatness of this book.

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*For the word بارى see GLOSSARY.

The BOOK is great indeed, as it is sent by Allah, the Sovereign of the universe, Whose authority and control are not shared by any other power; and Who possesses knowledge of the present and the future, visible and the invisible, manifest and the atent, actual and the potential. (It is only from the human point of view that these distinctions are made, otherwise to him everything is visible, present and manifest). Whatever means of growth and development are required for the actualisation of the potentialities of His creation, He provides them within a specified pattern and without reward.

He is the same Allah, besides Whom there is no other Sovereign. His authority reigns supreme. He Himself is the most perfect and flawless, and He grants means to everyone for making his personality perfect. He guarantees security to his creation and nothing escapes His supervision. He has full powers to execute His programme. Everything is so firmly bound by the splints of His laws that nothing can deviate a bit from its prescribed role and thus disturb the universal order. He is high above all and far beyond this that any other power be considered to be a partner to Him.

He is the Creator, the Evolver; and brings the created object to their required forms by subjecting them to various forces of evolution.

Above described are some of His attributes, otherwise all sublime attributes are centered in Him in perfect harmony. All that is in the heavens and the earth steadfastly follow His programme ; He is exalted in Might, which He exercises with absolute balance and discrimination."

GLOSSARY

(OF SOME QURANIC WORDS PRESENT IN THIS BOOK)

اثم	ا ث م	Debility, Prostration.
اجاج	ا ج ج	Intensely bitter water.
آخِر	ا خ ر	A thing or event that follows but is not followed by one of the same or similar kind. A last link in a chain of events.
آخَر	ا خ ر	New and distinguished.
ملٰئكة	ا ل ك	Messengers. Forces of nature.
الله	ا ل ه	Whose authority prevails. One Who can give protection against dangers. One Who can be implored to remove difficulties.
امر	ا م ر	Guidance, command or guidance by command. Also means a stage in the process of creation where a thing is in the process of becoming and has not yet appeared in a concrete form. Allah's Directive energy.
امن	ا م ن	Peace of mind. Satisfaction. Freedom from worries and outside dangers. Conviction. مومن Those who are convinced of the truthfulness of the Divine order.
اناثاً	ا ن ث	Weaker sex. Females.
آيت	ا ى ى	(1) A sign, token or mark by which a person or thing is known. It generally signifies a perceptible object, through which an abstract truth is conceived; e.g., a natural phenomenon which serves as an indicator to the existence of an omnipotent, all-wise Being (Allah) behind the universe.

		(2) Laws of nature and the Quranic laws revealed to the Messenger of Allah. (Plural اٰیٰت)
يَبُثُّ	ب ث ث	Multiplication and spread.
بحران	ب ح ر	Massive quantity of water, whether in an ocean or river or anywhere else. A massive portion of hydrosphere.
يَبْدَؤُ	ب د ا	To initiate.
باری	ب ر أ	To sort out things and eliminate the incompatibles. The Holy Quran says that Allah is خالق البارى المصوّر i.e., He creates; He sorts out things not fit for survival from those that are capable of surviving and passing on to their higher scales of evolution; and thus He gives objects their perceptible and distinct forms.
برّ	ب ر ر	Expansiveness.
برزخ	ب ر ز خ	Curtain. Barrier.
بُرِكَ	ب ر ك	Self-perpetuation. The scientific term self-perpetuation covers all the characteristics of the word برکت i.e., preservation, stability, growth, development and manifestation.
بصر	ب ص ر	Vision.
بعثرت	ب ع ث ر	To turn upside down.
بعثت	ب ع ث	Emergence of new life. To remove obstacle. To set free.
بقا	ب ق ی	To remain unchanged.
نبتلیه	ب ل و	To bring into light the real nature of a thing. To rotate.
بنٰها	ب ن ی	Structure.
بیض	ب ی ض	White.
بیع	ب ی ع	بَيْعٌ --To sell or to buy. بِيعة --Church.
تراب	ت ر ب	Dust.
ترائب	ت ر ب	Two similar objects lying opposite to each other. Such as Pelvic bones.

تثبيتًا	ث ب ت	Perpetuation. Stability.
مثقال	ث ق ل	Weight, Very small.
يَجْرِمَنَّ	ج ر م	To incline to do a thing.
جوار	ج ر ى	To flow without hindrance.
أَجنحة	ج ن ح	Arm. Wings of a bird.
اجنّة	ج ن ن	To hide. 'JINN'-a hidden object.
متجٰورٰت	ج و ر	To leave the path of justice. الجار --neighbour. قطع متجورٰت --Adjoining tracts of land.]
حسير	ح س ر	Worn out. Prostrate.
احسان	ح س ن	Beauty. Proportion. A condition where an individual, if inspite of his best efforts, lags behind, his deficiency is made good by others to restore the disturbed proportion of the society.
حما	ح م ا	Stale, black, altered mud.
حمد	ح م د	The spontaneous expression of feelings of appreciation of the beauty, proportion and perfection of a concrete object.
حفظًا	ح ف ظ	To protect. To guard against.
حَقّ	ح ق ق	A finally proved or established truth. A reality that cannot be challenged. A constructive thing.
حكيم	ح ك م	To harness. To prevent going astray. To place a thing in its proper position and in exact proportion.
حطامًا	ح ط م	Powder. Fire that turns into power. To break.
حين	ح ى ن	A period of time. An indefinite portion of history.
حي	ح ى ى	Life. Contractility. Sensation. Growth. Mental awareness and receptivity.
خاسئًا	خ س ا	Sense of humiliation. Dull and discomforted.
خصيما	خ ص م	To quarrel. To dispute. To fight for.
خلق	خ ل ق	Generally means to create a new thing, out of the material that already exists.

خنّس	خ ن س	To recede.
خائنین. یختانون	خ و ن	To betray the trust. To lose confidence.
یختار	خ ی ر	To choose better. Natural selection. (Absolute Good-vs-Evil......in Ethics.)
خیرۃ	خ ی ر	Any action with a bright future.
دائبین	د ا ب	Perpetually.
دابّۃ	د ب ب	The creeping, crawling and walking animals.
مدبرات	د ب ر	To plan. To readjust things with a purpose of leading them to their destination.
دحٰی	د ح و	To spread.
دخان	د خ ن	Smoke. Gas.
دسّٰی	د س و	To hide. To bury.
دافق	د ف ق	Spurting.
دھر	د ھ ر	Time with no limit (as supposed by some philosophers). Indefinite continuous duration.
ذٰریات	ذ ر و	To spread. To diffuse.
ذکور	ذ ک ر	ذَکَر --Male, ذِکر --To bring to mind.
رب	ر ب ب	'Rabubiyyat' is one of the attributes or basic characteristics of Allah, which means the provision of sustenance to an object, from its initial stage to the stage of final destination.
ربٰو	ر ب و	Unearned money. Acquisition of wealth without putting in any labour. Profiteering. Capitalist economic system.
فارجع	ر ج ع	To return. To come back to original position.
راجفۃ	ر ج ف	Forceful vibrant motion. Violent commotion.
رحیم	ر ح م	One who provides nourishment within a specified pattern (as for example, inside mother's uterus)
ارسٰھا	ر س و	To get implanted.

رشد	ر ش د	To be steadfastly on the right path. To possess wisdom and capability of reaching correct decision. رشید --One who shows the right path.
مرعٰها	ر ع ی	Pasture. To feed the cattle, as well as to keep an eye on the cattle.
رفاتاً	ر ف ت	Powder.
تركبنّ	ر ک ب	To ride. To place one thing upon the other. To ascend. To rise step by step.
روح	ر و ح	Basically the word means energy which causes movement. When attributed to Allah, it means the faculty of free Will given to man by Allah.
زکوٰة	ز ک و	Growth. Nourishment.
زوج	ز و ج	Pair. Two objects which are complementary to each other, and together make a complete whole.
سَبَحَ	س ب ح	To swim. To move swiftly. To make strenuous efforts.
سبل	س ب ل	Tracks. Paths. Lines of travel or motion.
سَخّر	س خ ر	To conquer or make submissive the forces of nature. سَخَر --To joke. To make a fool of. To subdue.
سراج	س ر ج	Source of light.
سللة	س ل ل	Extract.
سمع	س م ع	Sense of hearing. سميع --One who possesses an indefinite reach of hearing.
سَمْكَهَا	س م ک	Roof.
سماء	س م و	Heaven. Anything situated at a higher level in relation to particular object, or surrounding it, is its 'Sama'.
سنّت	س ن ن	Ways. Methods, Laws as practised.
السن	س ن ن	Age.
ساء	س و ا	Unpleasant.
سود	س و د	Black غرابيب سود--Jet black.

تسیمون	س و م	To find. To explore. To mark. To feed cattle.
سوّٰی	س و ی	To have exact proportion. Balanced.
شیطان	ش ط ن	Rebellious. Fiery. Destructive. Baser sentiments.
انشقت	ش ق ق	To cut open.
شنآن	ش ن ا	Enmity with misbehaviour.
شهادۃ	ش ه د	To be present. To present accurately what is known. To give evidence. Manifest thing. Perceptual.
مشیت	ش ی ا	'Mashiyyat' is generally translated as 'Will'; as for example, " یخلق ما یشاء "is translated as "He creates what He wills." But there is a difference between 'Will' and 'Mashiyyat'. Allah is the sovereign of the universe, but He does not exercise His powers like mortals, who use them according to their whims and wishes. He has created the universe on the basis of certain laws. It is a world of cause and effect. Every effect has a cause behind it. The fire burns and always burns. Nobody can explain why the fire has got a burning property. This property originated with the creation of fire. It is a 'Mashiyyat' of Allah that fire always burns. Similarly all phenomena of nature are bound by a set of laws which never change. Thus the Quranic terms ما یشاء or من یشاء would mean "According to the set of laws originated by Allah which are unchangeable."
مصابیح	ص ب ح	Red cololur. 'Morning, is called صبح because the sky is red at that time. مصباح --Lantern--as it emits red light. اَصْبَحَ --Happened to become.
تصریف	ص ر ف	To change place repeatedly. To bring into circulation.
مصفرًا	ص ف ر	Yellow colour.
یصطفی	ص ف و	Chosen. Clean. Pure. Unadulterated.
صلب	ص ل ب	Vertebra.

صلصال	ص ل ل	Wet earth or mud, when it reaches a certain stage of dryness.
صلوٰة	ص ل و (ۃ)	To follow closely the Divine laws.
صلوات	ص ل و	Synagogues.
صوامع	ص م ع	Monasteries.
صنوان	ص ن و	Branches of a tree emerging from a common trunk. غیرصنوان --Branches emerging from different trunks.
ضحٰها	ض ح و	Time after sunrise.
طباقًا	ط ب ق	A cover that fits over the covered object. Congruous.
طحٰها	ط ح ی	To spread. Wide expanse.
اطوارا	ط و ر	Stages.Kinds. Limits. Environments.
طین	ط ی ن	Wet earth. Mud.
ظلم	ظ ل م	To put a thing at a place where it should not be. To disturb proportion. To usurp other people's rights.
عباد	ع ب د	To do a thing with inclination of mind and to undergo hardship to achieve a profitable end. To develop your potentialities within the pattern of Divine laws and use them for the benefit of humanity. To harness.
عدل	ع د ل	Justice in all spheres of life. Justice means a condition where every individual in a human society gets what is due to him, by way of the fundamental rights that belong to him by virtue of being a man.
عدوان	ع د و	To be at a distance from each other. To drive a wedge in between, to keep the two parts of wood separate. Enmity.
عذب	ع ذ ب	Sweet and pleasant water. (But عذاب means chastisement
عذراً	ع ذ ر	The feelings of one's faults and weaknesses. An excuse.
یعرج	ع ر ج	To climb up step by step.
یعرشون	ع ر ش	Pillar. Throne. Authority.

معروف	ع ر ف	To recognise. To know a thing from its manifest signs. معروف --Those affairs that are recognised by the Divine laws as good ones. Customary. عرفًا --Beneficial.
عزيز	ع ز ز	Powerful. Dominant.
عصفًا	ع ص ف	Dry powdered leaves.
عظما	ع ظ م	Bones. Skeletal system.
عقيم	ع ق م	Unfertile.
علقة	ع ل ق	A hanging object attached to a fixed object higher up. Early embryonic stage.
عليم	ع ل م	Knowledge. عليم --One with unlimited knowledge.
يعيد	ع و د	To do a thing repeatedly. To return.
غرابيب	غ ر ب	غرابيب--Black غرب --West. To go to a distant place. (غريب الوطن --One away from home)
يغشها	غ ش ی	To cover completely.
اغطش	غ ط ش	To produce darkness.
غفور	غ ف ر	To hide. To give protection.
غي	غ و ی	To swerve from the right path. To get deceived.
غيب	غ ی ب	Out of sight. Hidden. Imperceptible.
افئدة	ف ا د	Mind.
فترة	ف ت ر	Swiftness turning into sluggishness. Harshness turning into softness. Slowing down of any activity. Interval.
ففتقنهما	ف ت ق	To rupture. To clove asunder.
فجور - فجرت	ف ج ر	To burst open. To break through. To disintegrate.
فاحشة	ف ح ش	To exceed boundaries set by Divine guidance.
فخر	ف خ ر	Pottery.

فخر	ف خ ر	To make a show of qualities which one does not really possess.
فرات	ف رت	Very sweet water.
فرث	ف رث	A thing broken into pieces. Excretion.
فساد	ف س د	To become decomposed. To become out of order. To become unbalanced.
فاطر	ف ط ر	To do a thing for the first time. To initiate. To incise or cut into.
يفقهون	ف ق ه	To understand. To find out abstract truths by observation of concrete objects.
نأن	ف ن ی	To undergo a process of gradual disintegration.
قدّر	ق در	To make a thing according to certain measures. تقدير is model or pattern according to which a thing is made and which it ultimately reaches by development.
قسط	ق س ط	Division based on justice.
قصاص	ق ص ص	Law of requital. To follow up the criminal so that he does not escape without punishment.
قضٰی	ق ض ی	The end. The completion. To decide finally.
مستقر	ق رر	A place of rest during a journey.
اقوٰتها	ق وت	Food production. Food sufficient for sustenance. Nutrition.
قوامين	ق وم	Stability. To stand firm. To supply means of sustenance.
انکدرت	ک در	To become polluted. To become dim.
کرّتين	ک رر	To repeat. To return. To change direction.
کافر	ک ف ر	To cover. To conceal.

کافر --One who keeps the truth under cover. According to the Holy Quran there is only one criterion for the division of humanity and that is on the basis of ideology. Those having a complete confidence in the Divine laws are

		known as مومن and those who do not believe in the Divine laws are known as کافر .
اکمام	ک م م	A cover that envelops the budding flowers. Vessels that protect seeds in a flower.
کنّس	ک ن س	To go into hiding. جوار الکنّس --A heavenly body that moves in its orbit without any obstruction and still goes into hiding for a long period (a comet).
کوّرت	ک و ر	To roll over.
اولوالالباب	ل ب ب	Those who use intellect. Men of deep thinking.
لحم	ل ح م	Flesh. Muscles or muscular system.
لازب	ل ز ب	Sticky.
لعب	ل ع ب	Without seriousness of purpose. Purposeless.
لقاءنا	ل ق ی	Confrontation.
فالهمها	ل ھ م	To place a certain thing at a certain place.
یمحو	م ح و	To remove all traces. Extinction.
مدّت	م د د	To spread. To level down.
مرج	م ر ج	To intermingle. To let free.
مارد	م ر د	Rebellious. Fiery. Destructive.
ملح	م ل ح	Very saltish and bitter water.
مسلمون	م س ل	Islam means a social order with the following characteristics: (1) Perfection (2) Safety (3) With means to attain the pinnacle of glory through evolutionary processes (4) Peace (5) The individuals in this social order submit to Divine laws (6) Well balanced (7) So that all efforts bring fruit and no effort is wasted. (8) Resulting in beauty and proportion in the social order.
مضغة	م ض غ	Embryo.
یمکث	م ک ث	To wait patiently. To stay.

مَكَّنّٰهُمْ	م ک ن	Authority. Stability with peace. Also means place or direction.
ميت	م ی ت	Death. Stoppage of growth. Blockade of progress. Loss of sensation. The cessation of psychological functions. Mental inertia.
تميد	م ی د	To move. To rotate. To bring means of sustenance.
انتثرت	ن ث ر	To disperse. To go waste.
نزعت	ن ز ع	To untie with force. To detach forcibly. To pull out. To snatch away.
نذرًا	ن ذ ر	To take upon oneself certain responsibilities for the sake of protection against harm. To become aware and alert against danger. انذار --To warn against danger.
انشانہٗ	ن ش ا	To begin a new life. An ascending life. To rise step by step. To originate. To bring into existence.
ينشرون	ن ش ر	To spread out. To disperse. To grow. To get a new life.
نشطت	ن ش ط	To untie with ease. To set free willingly.
نطفه	ن ط ف	Clear fluid. Sperm drop. Reproductive unit.
ونفخت	ن ف خ	To blow in. To bestow.
نفس	ن ف س	Individual. The sum total of the inherent and manifest qualities of an individual. It also means "human personalilty". Breath. (It is a comprehensive term, having a wide range of meaning).
منكر	ن ک ر	Very clever and deceitful. Affairs not recognised by Divine law.
نور	ن و ر	Light.
اوحی	و ح ی	To suggest swiftly. Divine guidance, amongst inanimate as well animate objects; amongst animals through instinct and

		amongst human beings by words of Allah communicated to them through His messengers.
مستودع	ودع	A place where at the end of one stage, an object is handed over to the next stage. A safe resting place. A temporary abode. To deposit. To leave. To vacate.
ترثو	ورث	To inherit. To become master or owner.
وسق	وسق	To bring together miscellaneous objects.
موعظة	وعظ	To impress upon one's mind the consequences of rightful or wrongful acts. It is not only a matter of advice but also a matter of command.
وقر	وقر	Heavy. Massive. Grand.
تقع	وقع	To fall down.
تقوى	وقی	To protect against harm. To keep an eye upon.
يلج	ولج	To enter quietly and gradually.
اولياء	ولی	Near one. Friend. Helper. Guardian. Custodian. Dependable associate.
وهاجا	وهج	To burn. وهاجًا --Source of heat and light.
هدّمت	هدم	To dismantle a building. Vertigo.
هالك	هلک	To undergo the breaking up process. Catabolism.
يهيج	هیج	To move. To bring into motion. Drying up of vegetation.
يوم	یوم	Day. Era. Period.

Note.-An Era starts with a particular event, e.g., Christian Era started from the birth of Christ. So did Mesozoic Era started from Appalachian Revolution and Cainozoic Era started from Larmide Revolution. Thus the word Era represents the Quranic word يوم more closely (See ستّة ايام in the text). The word "period" on the other hand is used in different senses in English literature. Firstly the round of time marked by astronomical coincidences, e.g., time of planets' revolution. In this sense the word ' يوم ' may also be described as 'Day' or

'Period'. On the other hand, the word period is also used for 'an indefinite portion of history, life etc.'and here it is analogous to the Quranic word حين (76:1). Lastly, the word 'Time' means an indefinite and continuous duration and this is exactly what the word دهر indicates.

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